ARGONNE NATIONAL LABORATORY

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DISTRICT HEATING AND COOLING: A 28-CITY ASSESSMENT

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August 1983

work sponsored by

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Assistant Secretary for Community Planning and Development
Energy Division

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ACKNOWLEDGMENTS

Funding to prepare this report was provided to Argonne National Laboratory (ANL) by the U.S. Department of Housing and Urban Development (HUD) under interagency agreement No. IAA-9-81 with the U.S. Department of Energy. For HUD, Wyndham Clarke, of the Energy Division in the Office of the Assistant Secretary for Community Planning and Development, supplied demanding and professional project oversight. He was assisted by Bernard Manheimer and Arthur Stellhorn.

A special debt of gratitude is owed to those local project observers who attended project meetings and faithfully reported their observations and perceptions to the ANL information coordinator and responded to follow-up inquiries. Their reports serve as the principal data base for this report.

Additional assistance and support was provided by staff members of Oak Ridge National Laboratory, principally Michael Karnitz and Martin Broders. Finally, the following ANL staff members assisted in the preparation of this report by providing information and analytical support: Philip H. Kier, Allen S. Kennedy, John Tschanz, Norman F. Kron, Jr., Elliott Levine, Lawrence J. Bryant, and James Matousek.

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Roya Road
Springfield, VA 22161
NTIS price Codes
Printed copy: A05
Microfiche copy: A01

Distribution Category:
Energy Conservation-Buildings and Community Systems
(UC-95d) ANL/CNSV-43

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ABSTRACT

This report presents findings of a project that assessed the potential for construction of district heating and cooling (DHC) systems in 28 U.S. cities. Supported by the Department of Housing and Urban Development and the Department of Energy, the project sought to determine whether DHC could promote local community and economic development. In the preliminary assessment, 17 of the cities identified up to 23 projects that could be built within three to five years. Most of these projects would rely on nonscarce heat sources such as refuse or geothermal energy and, to improve financial feasibility, the majority would cogenerate electricity along with heat. Many would use existing power plants or industrial boilers to hold down capital costs. Overall, the projects could generate as many as 24,000 jobs and retain $165 million that otherwise could leave the communities, thereby helping to stabilize local economies.

1. INTRODUCTION

This is a report of the results of Phase I of a program to assess the potential of district heating and cooling (DHC) systems in communities eligible for Community Development Block Grants (CDBGs). The program has been funded jointly by the U.S. Department of Housing and Urban Development (HUD) and the U.S. Department of Energy (DOE). Its purpose, as indicated in the Request for Cooperative Agreement application released by HUD on November 17, 1980, is to "assist cooperating parties to identify potential district heating projects which will contribute to CDBG communities' achievement of national and local community development objectives, to assess their feasibility, to develop community consensus on whether to proceed with a project, and to develop and initiate implementation of a plan of action for developing a DHC."

As a result of this request, to which 111 communities replied, 28 cities were selected. Agreements were signed and work began about July 1981 and ended between July and November 1982. Concurrently, an agreement was concluded between HUD and Argonne National Laboratory (ANL) to monitor and collect information about the 28-cities for preparation of a summary report of the principal findings. ANL was assisted by Oak Ridge National Laboratory (ORNL) in the monitoring work. This report is the result.

THE DISTRICT HEATING AND COOLING PROGRAM

District heating systems* have been in operation in this country for about 100 years. A district heating system is defined in the Cooperative Agreement as 'an energy system that generates thermal energy from one or more central plants to serve a multiple number of buildings and customers with thermal services through a piping distribution network and, where possible, a storage facility.' Although they proliferated in urban areas in the early 1900s, many such systems have fallen into disrepair and the number of customers has declined as low fuel prices made in-building systems the preferred approach to space heating.

*The terms "district heating and cooling" and 'district heating' are used here interchangeably. Although both heating and cooling were considered in some communities, the overwhelming concentration was on heating services.

With the rise in fuel prices in recent years, there has been renewed interest in district heating and cooling in this country, especially in light of experiences in northern European countries where such systems are in wide use. DOE has supported a considerable amount of research and development in this area. HUD has been interested in the potential of such systems to contribute significantly to CDBG communities' ability to achieve the nationally established objectives of community development articulated in Title I of the Housing and Community Development Act of 1974. The systems would lower energy costs, reduce environmental pollution, and expand local economic opportunities, particularly for persons of low and moderate incomes.

This interest was expressed most directly in the joint HUD/DOE funding of these 28 assessment projects. Under the cooperative agreement, each city was awarded a relatively modest sum (averaging approximately $50,000), principally to identify district heating projects that would be cost-effective, feasible, and able to enhance the communities' abilities to use CDBG funds to meet national and local community development objectives.

To meet the objectives of the agreement, each city was to complete the following tasks:

- Prepare a management/work plan.
- Identify potential district heating projects.
- Assess the economic and technical feasibility of alternative projects and the relationship of the projects to the objectives of national and local community development programs.
- Assess institutional factors (such as regulations, role of utilities, rate and pricing considerations, and hook-up policies).
- Hold a public meeting.
- Prepare a plan of action.
- Share assessment results with other interested communities.

As an assessment, the project was not expected to result in a detailed design of one or more systems. Rather, it was anticipated that the work would focus on one or more "doable" projects, i.e., those likely to be brought to fruition within one to three years and with a plan for doing so.

Following the work of Phase I described in this report, a second phase was expected that would make funds available on a cost-sharing basis to conduct detailed design study and other preconstruction activities to bring feasible projects to the construction phase. (Subsequently, three such awards have been made; others are to follow.)

MONITORING: THE ROLE OF ARGONNE NATIONAL LABORATORY

Recognizing the great potential for learning from a "real world" experience, HUD designated ANL to collect and analyze information on the assessment -process and its results. A preliminary report was prepared and presented at the November 1982 wrap-up meeting in St. Paul attended by representatives of each of the 28 cities. Thirty other cities interested in district heating also were represented. This report expands on and updates those preliminary findings.

Information about the cities and their project activities has come from a number of sources. The major source has been a series of case-study reports supplied by local project observers. Under terms of its cooperative agreements with HUD, each city employed an independent observer to observe the local process and to report, using standardized formats, to the ANL information coordinator. These individuals were university faculty members, consultants, members of civic groups, etc., who attended work group meetings, had access to working documents, and in some instances conducted interviews.

Certain technical information - principally engineering and economic was supplied in "project data forms" prepared under the direction of ANL and ORNL. These forms were completed in conjunction with local project staff and consultants by technical support representatives (TSRS) members of the ANL and ORNL technical staffs who provided assistance to specific cities. The principal TSR role was to supplement skills available locally or through consultants and to help find additional technical information from the district heating literature or from other experts. Argonne TSRs served 16 cities, while Oak Ridge TSRs served 12.

Under contract to Argonne, the firm of Resource Development Associates, Inc., analyzed some of the data in the project data forms using its proprietary district heating analysis model. Results are included in Section 8 of this report.

A third source of information was the series of reports prepared by the cooperating communities as the final project "deliverable." For those cities that contracted with private consultants to perform the work under the agreement (almost all), the consultants' reports serve as the actual final reports. In a few cities, city staff prepared separate reports or supplemented the consultant reports with additional material. Supplementary information was sought from TSRs and, on several occasions, from local project leaders by mail or phone.

Overall, a substantial amount of information is available about each of the 28 cities and their projects. While this data base is extensive, it is far from uniform in its depth and in the quality of information available about each city. As Table 1 indicates, not all local observers supplied reports, nor has there been access to final reports from all the cities. And technical data from the project data forms were not available from all cities; for example, the district heating projects for which data were supplied on the project data sheets were not necessarily those most likely to be built soon. Some reports described systems that would be fully developed in stages only over a number of years, rather than smaller systems that could be operating soon, i.e., so-called "early-start" systems. Thus there is some inconsistency in the data available. In general, the data are current as of the end of 1982.

Beyond completeness, the nature of the information supplied, particularly by local observers, was highly variable; this is inevitable when dealing with 28 sources.

Finally, and of special importance, the communities did not all begin at the same point. Some had had considerable interest and perhaps experience in district heating and were therefore able to make more rapid progress. To others, perhaps most, the cooperative agreement was their first opportunity to consider district heating, which often meant that a fair amount of time was spent in educating staff, work group members, and the public.

Because the cities started at different points, they necessarily ended at different points, some (as will be noted later) virtually beginning construction of new systems and others still at the stage of having to resolve important technical or institutional questions.

Table 1 Data Sources for the 28 Cities

City	Local Observer Final Report	City or Consultant Final Report	Project Data Form
Albany, N.Y.	x	x	x
Allentown, Pa.x	x	x	x
Atlanta, Ga.	x	x	x
Atlantic City, N.J.	x	x	x
Baltimore, Md.	x	x	x
Bellows Falls, Vt.	x	-	x
Berlin, Md.	x	x	x
Cambridge, Mass.	x	x	-
Campbellsville, Ky.	x	-	N
Columbus, Ohio	x	x	x
Dayton, Ohio	x	-	x
Devils Lake, N.D.	x	x	x
Ecorse, Mich.	x	x	x
Fort Wayne, Ind.	x	x	x
Galax, Va.	-	x	x
Gary, Ind.	-	x	x
Holland, Mich.	x	x	x
La Grande, Ore.	-	x	x
Lawrence, Mass.	-	x	x
Lewiston, Me.	x	x	x
Missoula, Mont.	x	x	N
New York, N.Y.	x	x	x
Norwalk, Conn.	x	x	x
Provo, Utah	-	x	x
Richmond, Ind.	x	x	x
Santa Ana Pueblo, N.M.	x		*N*
Springfield, Mass.	x	x	x
Thermopolis, Wyo.	x	x	x

N= no local project identified.

These distinctions in data sources, local activities, and results necessarily complicate the analysis. In the following sections, the number of projects discussed varies because different data are used. Moreover, a certain amount of judgment has been used in characterizing and classifying activities and results. Generalizations are made where they are suggested by the evidence available; special note is taken of exceptions to general findings and of particularly interesting examples.

Finally, a technical companion to this report, relying exclusively on the project data forms, has been published by Argonne as *District Heating and Cooling: A 28-City Assessment* - Technical *and Economic Summary* (ANL/CNSV-TM-119). It covers three topics - service areas and energy demands, heat sources and supply networks, and project economics that are dealt with here in only a cursory way.

2 SUMMARY OF MAJOR FINDINGS

The 28-city demonstration showed that the potential for district heating is great and that cities can reap a number of important benefits as a result. The major findings are summarized here and are discussed in detail in Sections 3-8.

Projects Identified

- Of the 28 cities, 17 have identified up to 23 "probable early-start projects,' i.e., those that may be under construction within three to five years. Three of these cities - Devils Lake, Lawrence, and New York - have begun or will shortly begin construction. Seven projects have obtained local commitment for preliminary design. The remaining 13 projects appear feasible, but further work is needed.

- Three of the cities - Lawrence, Baltimore, and Provo were selected in the first round to receive support for Phase 11; several other cities are sufficiently convinced of the merits of district heating as a result of the assessment and expect to move ahead on their own.

Project Characteristics

- Many projects expect to start out small by "anchoring" with a few large users; expansion would occur later after the system's economics are proved.

- Except for cities that would expand existing systems,district heating use of premium fuels - oil and gas would be limited.

- Refuse would supply heat to 11 systems, and -4 would use geothermal energy.

- Twenty-one projects would cogenerate heat and electricity; 7 would use heat-only boilers.

- Projects using existing equipment or pipes are likely to have superior economic performance.

- Utilities would participate in projects in several ways, usually by purchasing cogenerated electricity.

- A wide range of ownership options is being considered, many of which would probably involve public/private partnerships.

Participation in the Assessment

- Participation in the decision-making process was widespread; the most active participants were city officials, major potential suppliers, major users, and consultants.

- Assessment work groups began as large bodies, but gradually were reduced to only the major interested parties as attendance declined.

- Assessment work groups performed many activities, including providing private sector input, supervising the technical analysis, supplying data and technical support, conducting special studies, providing community perspective, building public support, and developing final recommendations.

- The public, apparently viewing the assessment work as largely a technical analysis, has given it relatively little attention.

- A number of means were used to generate public interest, including market analyses, media coverage, plant tours, support by political and civic leaders, and public hearings.

Obstacles to Project Success

- Two major factors may pose barriers to success: (1) low cost of competing fuels and (2) customer thermal density too low to support a district heating system.

- Regulatory or environmental obstacles can likely be overcome if a project is economically feasible.

- Strong public or political support may not be needed for a project with evident economic benefits.
- But a system requiring public involvement can be stopped or seriously delayed by leadership opposition, skepticism, or apathy.

- Refuse-fired projects are particularly sensitive to the need for careful handling of both air quality and siting considerations that anticipates neighborhood opposition.

Community Benefits of District Heating

- Potential total capital investment in the identified projects could be in the range of \$500 million to almost \$1 billion.

- Total project construction could generate up to 6700 onsite construction job-years, plus an additional 17,500 offsite jobs.

- As a result of project construction, the cities could expect to retain a grand total of \$165 million annually in their local economies.

- The cities expect district heating systems to support their revitalization efforts by helping retain struggling businesses and industry, improving their competitive position, lowering governmental costs and helping stabilize tax rates, reducing operating costs for housing (particularly public housing), improving air quality, and reducing waste disposal problems by using refuse as a heat source.

Financing Project Development

- Projections by the cities indicate that many may be able to obtain local financing for project design and development.

- Others, however, indicate that they could benefit from federal support, either specifically earmarked for district heating or from such sources as CDBG or Urban Development Action Grant (UDAG), to (1) fund the detailed design work required to obtain project financing (Phase II), conduct tests to determine technical feasibility of an apparently attractive project (e.g., test drilling for geothermal resources), (3) provide technical assistance in analysis and project design, and (4) overcome initial negative cash flow of projects with long-term economic and community benefits.

These major findings are discussed in detail in the sections that follow.

[Fig. 1--not included--is a map of US showing the location of the 28 cities. See Table 1 for a list of cities.]

3. CITY CHARACTERISTICS

Participation in this cooperative agreement was limited to CDBG entitlement cities. These cities were therefore required to meet certain standards related to economic health and housing.

As a result, the participating cities are heavily concentrated in the Northeast, and only six cities are west of the Mississippi . Most are older cities with relatively stagnant economies and with central areas - the most likely areas for district heating - often in need of revitalization.

All but one (Atlanta) has at least 4000 annual average heating degree days, which is the value generally used to define a substantial heating season. But even in Atlanta, a district heating system has served the downtown area for many years.

Table 2 shows selected characteristics of the 28 cities. They range in population from 7,000,000 in New York and almost 800,000 in Baltimore to only 500 in. the Santa Ana Indian Pueblo of New Mexico; several other cities have populations under 10,000.

Table 2 Selected Community Characteristics

City	Population (1980 or current estimate)		Principal Resid./Commercial Heating Fuel a	City Existing DHC System?.	Type b
Albany	127,000	ornl	NG	Yes - state offices	cc
Allentown	103,000	ornl	NG	No	cc
Atlanta	437,000	anl	NG	Yes CBD c	cc
Atlantic City	50,000	anl	NG	No	cc
Baltimore	783,000	ornl	NG/FO	Yes CBD	cc
Bellows Falls	5,500	anl	FO	No	FS
Berlin	2,000	anl	FO	No	FS
Cambridge	96,000	ornl	NG	Yes CBD	Sub.
Campbellsville	10,000	ornl	NG	No	FS
Columbus	593,000	anl	NG	Yes CBD Univ	cc
Dayton	193,000	anl	NG	Yes CBD	cc
Devil.s Lake	7,500	anl	NG	Yes CBD	FS
Ecorse	14,000	anl	NG	No	Sub.
Fort Wayne	182,000	anl	NG/FO	No	cc
Galax	6,500	ornl	FO	No	FS
Gary	152,000	anl	NG	No	cc
Holland	26,000	anl	NG	Yes college	FS
La Grande	11,000	anl	NG	Yes college	FS
Lawrence	65,000	ornl	FO	Under construction	Sub.
Lewiston	41,000	ornl	FO	No	FS
Missoula	36,000	anl	NG	Yes univ	FS
New York	7,000,000	anl	FO/NG	Yes several	cc
Norwalk	77,000	anl	FO	No	cc
Provo	74,000	anl	NG	Yes- univ.	cc
Richmond	44,000	anl	FO	No	FS
Santa Ana Pueblo	500	ornl	d	No	FS
Springfield	165,000	ornl	FO	No	cc
Thermopolis	3,800	ornl	NG	No	FS

a NG = natural gas; FO = fuel oil.
b CC = central city; FS= free-standing; Sub. = suburban/inside metropolitan area.
c CBD = central business district.
d No data.
ornl=technical support from Oak Ridge National Laboratory
anl=technical support from Argonne National Laboratory

The cities are equally diverse when classified by type - 13 are central cities with more than 50,000 population; three are suburban, i.e., within metropolitan areas; and the remaining are free-standing communities of less than 50,000 outside of metropolitan areas. Overall, the 28 cities represented the high degree of diversity appropriate to a demonstration of district heating's potential.

The major fuel for heating residential and commercial buildings, based on the data available, is natural gas, used in 16 of the cities. Fuel oil predominates in the remainder, except in three cities that use both fuels. The New England cities, in particular, rely heavily on oil, which places a severe economic strain on both residents and businesses. The potential for district heating to replace with fixed-capital infrastructure a portion of the energy dollars now exported from the community is seen as a major economic benefit.

District heating systems 'now are in existence in at least 12 of the 28 cities, and one more is under construction. Several of these serve college campuses; most of the remainder are found in the densest parts of the central business districts (CBDs), where they serve multiple customers. All of the latter (except Devils Lake) are privately owned and operated by a local utility company.

Data on utility service are given in Table 3, which shows that the 28 cities represent the full range of types available, including public and investor ownership, combined and separate. In Baltimore, Cambridge, and Dayton, all utility services are supplied by one company.

This brief summary shows the diversity of the participants. Reference is made to these characteristics throughout the sections that follow. One finding that can be noted at the outset, however, is that it is only the unique combination of physical characteristics that is each community--combined with skills of individuals, commitments by firms and institutions, the legal structure, and many other factors--that determines the feasibility of district heating. That perhaps is the first lesson: while much can be gained from other communities' experience, only city-specific analyses can supply real answers for each locality.

Table 3. Utility Services in Assessment Cities

	Separate			Combined		
City	Electric	Gas	Heat	Elec./ Gas	Elec./ Heat	Elec./ Gas/Heat
Albany			P*	I		
Allentown	I	I				
Atlanta		I			I	
Atlantic City	I	I				
Baltimore						I
Bellows Falls	I					
Berlin	P	I				
Cambridge						I
Campbellsville	I	I				
Columbus	I, P	I	U			
Dayton						I
Devils Lake	I	I	P	P		
Ecorse	I	I				
Fort Wayne	I	I				
Galax	I	**				
Gary				I		
Holland	P	I	U			
La Grande			U	I		
Lawrence	I	I				
Lewiston	I	I				
Missoula			U	I		
New York	P	I			I	
Norwalk	P, I	I				
Provo	P	I	U	U		
Richmond	P	I				
Santa Ana						
Pueblo	I	**				
Springfield	I	I				
Thermopolis	I	I				

I = Investor-owned; P = publicly owned; U = university system.

* New project under construction. **No data.

4. ASSESSMENT FINDINGS AND STATUS OF PROJECTS

The aim of this assessment effort was to determine whether a district heating system appeared to be feasible in each of the participating cities and, if so, how such a system would support community and economic development programs. To analyze the results, the projects identified by the cities have been divided into four categories designated as (1) ready for construction, (2) ready for preliminary design, (3) having near-term potential, and (4) still facing major obstacles remain.

Criteria for determining the appropriate category for projects are as follows:

1. Ready for Construction
   a. Ground has been broken; construction under way; or

   b. Financial and other commitments have been secured; contracts have been, or are about to be, let; ground to be broken in the near future.

2. Ready for Preliminary Design
   a. A project has been found to be feasible in the assessment;

   b. Informal commitments have been given by heat suppliers and users; and

   c. There are no apparent remaining obstacles to completion of engineering designs and financial/legal packaging.

3. Near-Term Potential
   a. Assessment shows a positive outlook for a project;

   b. Additional analysis or marketing is needed; and

   c. Substantial community support is evident.

4. Major Obstacles Remain
   a. Near-term economic outlook for a project is unfavorable because of competing energy prices, unavailability of a usable heat source, or insufficient demand; or
   b. The assessment process has not progressed far enough to produce conclusive results.

These categories do not necessarily measure the degree of "success"; rather they more typically identify where the cities are on a time continuum. As such, the distinctions between categories are not precise; the need to create categories tends to obscure important internal distinctions. And as with other aspects of the assessment, the definition of "project" is not simple and straightforward. The assessment process involved an identification of likely heat loads and suppliers. In many instances various alternatives have been offered for further consideration, some more fully developed than others. These may be a single heat source serving a single customer, a single source serving one or more distribution "loops" (which can be characterized as one or more projects), multiple sources serving one or more interconnected loops, or unconnected systems served by separate sources. Many cities identified initial small systems with the potential for expansion in stages to encompass large parts of the city.

To simplify the analysis here, we have focused on those configurations identified locally as having the highest probability of successful implementation. In a few cases, we note secondary projects where sufficient information has been supplied.

For the purposes of analysis, the first three categories are grouped under the heading of "Probable Early-Start Projects." These are all projects that have a good chance of being built within the short term. Although a variety of uncertainties exist, the problems appear to be solvable. It is significant that 17 of the 28 cities have identified probable early-start projects, an overall showing that suggests a significant potential for district heating in U.S. communities.

Figure 2. Status of District Heating Projects

	Projects	Cities
Ready for Construction	3	3
Ready for Preliminary Design	7	3
Near-Term Potential	13	11
Major Obstacles Remain	14	11
Totals	37	28

PROJECTS READY FOR CONSTRUCTION

As shown in Table 4 and Fig. 2, three cities now have projects under construction: Devils Lake, Lawrence, and New York. In each, a combination of circumstances led to the rapid determination of project feasibility and the securing of project financing.

Devils Lake, North Dakota, has operated a municipally owned, natural gas-fired CBD steam system for many years. Because gas price increases and increased maintenance have drastically raised steam prices to customers, the assessment project was seen as a way to determine the feasibility of switching to alternative fuels (although some analysis had been done under previous planning grants) and expanding the distribution lines to add new customers. Although expansion was not appropriate at this time, it was determined that burning a combination of urban waste and wheat straw (both in adequate supply) would be most economical. A previously sought UDAG was approved for the conversion, which is now largely complete. The modernized system will continue to serve commercial and residential customers in the Devils Lake CBD, with the lower energy costs seen as a way of maintaining an older housing stock and improving the city's business climate.

Lawrence, Massachusetts, unlike Devils Lake, has never had a district heating system. But Lawrence, too,, used the assessment program to identify and bring to fruition a project that will likely have a major role in the city's community and economic development strategy.

A combination of three circumstances has allowed Lawrence to move rapidly into construction of its new district heating system: (1) the availability of a number of underutilized mill boilers, a legacy of the city's former textile-based economy; (2) previous agreement by Arlington Mills, Inc., to construct a large refuse-fired boiler on its property, using an $8 million UDAG to leverage more than $80 million in private investment; and (3) proximity of several thermal customers, including a paper mill and several public housing projects. The new facility also will cogenerate electricity to provide an additional revenue source. Two additional extensions of the system are being considered,, one to serve industrial customers with steam and the second to supply hot water, through heat exchangers, to the nearby Arlington neighborhood, Lawrence's poorest section. Other expansion opportunities also are being explored.

Table 4 Assessment Findings and Project Status

City	Probable Early-Start Projects: Ready for Construction	Ready for Preliminary Design	Has Near-Term Potential	Major Obstacles Remain	Status: Remaining Issues
Albany	---	---	Clinton Av. Extension	1.Institutional Loop 2 Union Station	Extension likely after initial Clinton Ave. Project is in operation; others are long
Allentown	---	---	---	Downtown Project	Coal fluidized bed project not now economically feasible. May consider other alternatives.
Atlanta	---	1. Peachtree Ctr. 2. World Congress Ctr 3. State Office Tower 4. South CBD	---	---	All "doable." Financing , ownership and institutional arrangements must be finalized.
Atlantic City	---	---	---	1. Marina Cove 2. Boardwalk 3. Ice pile/cooling	Each shows promise; more study needed. Marina Cove "most likely."
Baltimore	---	1.Cherry Hill 2.Hopkins/E. Balt.	---	---	Possible regulatory problem, but alternative arrangements possible.
Bellows Falls	---	---	---	Geothermal	Geology looks promising; need funds for drilling to determine aquifer capacity.
Berlin	---	---	---	Geothermal	Need about $500,000 to drill test wells; funding source is unclear.
Cambridge	---	---	---	Cambridge Street: serve 2 hospitals	Basic issue is uncertainty about willingness of private steam company to invest in expansion and to seek more rational cost allocation between thermal and electric svc.
Campbellsville	---	---	---	Gas-fired system to serve industry	Anticipated gas field found insufficient; may explore a municipal coal or trash-fired system.
Columbus	---	---		Ohio St. U/ CBD	Cost comparison with competing fuels (coal, natural gas) unfavorable for large system. Exploration of smaller project may show favorable results.
Dayton	---	---	2 loops: St. Elizabeths and Delco, served by Tait electric generating plant.	---	Major question is interest of Dayton Power & Light in expanding existing system and in retrofitting Tait plant (planned for phaseout) for thermal source.
Devils Lake	Steam plant Conversion	---	---	---	Conversion now under way.
Ecorse	---	---	---	Frenchman's Cove	Probability directly linked to success of Frenchman's Cove, a major mixed use development. May be phased in starting at fifth year.
Fort Wayne	---	---	---	Ultimate System	Analysis shows proposed system cannot compete with available fuels.
Galax	---	---	Hanes Underwear	---	Investigating financing mechanisms.

Table 4 Assessment Findings and Project Status (continued)

City	Probable Early-Start Projects: Ready for Construction	Ready for Preliminary Design	Near-Term Potential	Major Obstacles Remain	Status: Remaining Issues
Gary	---	---	Incinerator/CBD	---	Seeking private developer.
Holland	---	---	Municipal Power Plant Retrofit: CBD, Hope College	---	Seeking funds for Phase II.
La Grande	---	---	Institutional Corridor	---	Likely to proceed if low-cost pipe can be obtained or if test drilling finds nearby geothermal source.
Lawrence	New refuse-fired incinerator	---	---	---	Under construction
Lewiston	---	---	Refuse-fired cogen. system	---	Uncertain ownership arrangements and availability of funds for transition financing
Missoula	---	---	---	---a	No DHC project. No viable heat source to meet air quality standards, focus on conservation.
New York	Brooklyn Navy Yard	---	1.Kings Co. Hosp. 2.SW B'klyn Incin. 3.Betts Av. Incin.	---	Navy Yard project under way; others may proceed independently and concurrently.
Norwalk	---	Incinerator	---	---	Looking for private developer.
Provo	---	---	CBD/Brigham Young U.	---	Ownership and financing arrangements uncertain.
Richmond	---	---	West Richmond	---	Capital financing source uncertain.
Santa Ana Pueblo	---	---	---	---a	No specific project identified; further study needed. Capital availability a serious barrier.
Springfield	---	---	Downtown Springfield	---	Ownership/financing uncertain.
Thermopolis	---	---	---	Geothermal System	Public disinterest; concerns about effect on tourism-oriented hot springs; not yet competitive with gas.

a=No project identified.

New York used the assessment program to establish that the existing utility-supplied district heating system and existing electrical distribution network serving the developing Brooklyn Navy Yard industrial park project could readily be converted to supply thermal and electrical energy at a cost substantially lower than that currently in effect. In an initial effort, the city and the Navy Yard Development Corporation Installed temporary packaged boilers, made additional distribution system improvements, and lowered the cost of delivered thermal energy by 25%. Alternative technical and financial arrangements are being explored for implementation of a permanent long-range, comprehensive energy supply and delivery system. This will include cogeneration, alternate financing and management systems, and the feasibility of interconnecting the Navy Yard hot water system with city Housing Authority buildings located outside the Navy Yard.

Summary. These three cities now beginning construction have several characteristics in common that enabled them to rapidly leverage the limited assessment funds and develop projects that could be implemented quickly.

- A reliable source of thermal energy is (or could be made) readily available in relative proximity to one or more customers who need it.
- There were few or no institutional or legal obstacles.
- Funds for both design and initial capital financing were on hand; in all three instances, federal grants covered all the costs or were used to leverage additional funds.
- There had been substantial preexisting interest in district heating, and usually some research or engineering groundwork had been laid to enable progress to be made rapidly.
- Key interests were supportive and committed and worked together to develop and carry out the project.
- Costs of competing fuels were high and perceived as rapidly increasing.

The combination of these conditions is rarely found. Few cities are likely to break ground for a new district heating system within a year of obtaining funds to conduct an assessment. It is more likely that a highly favorable assessment result will lead to one or more projects that are sufficiently well-developed to be ready for preliminary design, as in the following instances.

PROJECTS READY FOR PRELIMINARY DESIGN

Three cities identified up to seven projects that are sufficiently advanced to enable preliminary engineering design and financial packaging to occur.These include four projects in Atlanta, two in Baltimore, and one in Norwalk.

Atlanta. The four projects identified by the study as candidates for early-start projects are located in or near Atlanta's central core, contain many of the city's major public and private institutions, and together incorporate most of the customers served by Georgia Power Company's existing steam system. These projects, along with five others, would be designed eventually for linking into a single hot-water system serving most of the densely developed areas of the city. Most of the thermal energy of this .. mature" system would come from cogeneration at Georgia Power's Plant McDonough facility. Various short-term sources for the early-start projects include expansion andintegrationof existing sources, supplemented by new coal- or refuse-fired central plants. The economic analyses for the four early-start projects show favorable returns; likely suppliers and users have provided project leadership, which suggests a high probability for implementation in the near future.

Baltimore, too, had a combination of circumstances that resulted in a high probability that two district heating loops will be provided with thermal energy from a central plant in the near future. The two projects are Cherry Hill, in southwest Baltimore, and Johns Hopkins University/East Baltimore. The former includes two public housing projects, several multifamily housing units, two public schools, and the South Baltimore General Hospital. The latter is located just east of the city's CBD, and the principal heat users include the state penitentiary and city jail, four public housing complexes, five public schools, and some residential buildings. Heat would be provided by a private firm that is under contract to the Northeast Maryland Waste Disposal Authority to build and operate a 2000-ton/day trash-fired incinerator that would cogenerate 50 MW of power.

Construction of the incinerator is about to begin, and operation should commence in about three years. With this source of thermal energy assured, the customer base committed to purchasing the hot water, and the financing arrangements virtually complete, there are few remaining obstacles.

Norwalk, Connecticut, is the third city with a project classified as ready for preliminary design. This project would be staged over a period of years, initially providing process steam for industrial use and space heating for a hospital and the YMCA. The principal heat source will be a new 250-ton/ day refuse plant with heat recovery and a cogeneration turbine for base load, together with an existing heat-only oil-fired boiler for peak load. This project would concurrently help resolve a critical refuse disposal problem in the city and provide additional revenue through cogeneration, while providing the direct benefits of district heating. Preliminary commitments have been [23]received from the potential customers. The city has advertised for private developers to construct the plant and has sent out requests for qualifications. Twenty-four responses have been received, of which four,are undergoing further consideration.

Summary. Although design of the Baltimore project is further advanced than that of Atlanta and Norwalk, the results of all three clearly indicate that district heating projects are likely to be constructed. In each case some questions remain unresolved, but conditions are such that they can probably be resolved in the near future.

PROJECTS WITH NEAR-TERM POTENTIAL

This third category includes a large and diverse group of cities in which the assessment resulted in a positive outlook for district heating projects; however, substantial additional work is needed before a firm goahead decision can be made. In general, this group can be characterized as having demonstrated technical and financial feasibility, but having yet to develop detailed financial plans, conduct marketing analyses, or obtain sufficiently firm commitments for purchase of thermal services.

Albany, New York. The city has solicited bids to build a district heating system, with heat supplied by a state-owned plant, that will serve a low-income neighborhood. Financing has come from a $1.5-million UDAG. Excess system capacity is built in and an extension of the system, called the Clinton Avenue Extension, will likely be built after the initial project has been operating for a short time, probably in 1985.

Dayton, Ohio. Two loops have been identified that strongly support this city's community and economic development strategy: (1) St. Elizabeth, serving a hospital and adjacent commercial users, and (2) Delco, serving industrial plants and public housing. The source for both would be an exist.ing coal-fired power plant of the Dayton Power and Light Company (DP&L) that would be retrofitted for cogeneration. This plant is now slated for mothballing; the major issue is the willingness of DP&L to reconsider its decision and continue to operate the plant either as heat-only or with cogeneration.

Galax, Virginia. This project would involve construction of a refusefired plant to supply process steam to one customer, Hanes Underwear, the city's largest employer. Preliminary feasibility has been demonstrated and alternative financing mechanisms are being explored.

Gary, Indiana. The result of this project is a recommendation to build a refuse-fired, cogenerating incinerator to initially serve two hospitals and part of the CBD, with possible later expansion. Some important questions about the project's feasibility remain unanswered; the city's approach has been to seek a private developer who would conduct a feasibility analysis and who could design, build, and operate the system if the analysis proved favorable.

Holland, Michigan. A project has been identified that has a high probability of success and that is tied closely to the city's development objectives. The existing coal-fired municipal power plant would be retrofitted for cogeneration under this plan. The first stage would include two factories, the CBD, and Hope College. A later expansion would cover a hospital, high school, proposed riverfront development, and a nearby mixed-use -- primarily residential - area. Commitments for much of the financing for engineer ing design have been given; additional commitments are needed before the planning can proceed.

La Grande, Oregon. Here, too, a project with a high probability of implementation hag been identified. Its energy source would be geothermal hot water that would be distributed to an "institutional corridor" consisting of the 2000-student Eastern Oregon State College, civic buildings, schools, and'a hospital. Geologic conditions appear favorable; test wells must be drilled to determine the adequacy of the geothermal resource.

Lewiston,, Maine. Incorporating a small district heating system in which a large mill supplies heat to an adjacent mill, the Lewiston system would be expanded to serve most of the CBD, including a substantial number of low-income households. The system would be base-loaded by a new refuse-fired cogeneration plant, with the existing oil-fired industrial boiler used for peaking. Major remaining questions center on ownership/financing arrangements.

Provo, Utah. A project has been identified that would use the existing Brigham Young University boilers and add new trash- and coal-fired cogeneration boilers to the electric generation plant owned by Provo City Power, the municipal utility. The cogeneration system would serve Utah Valley Hospital, Provo High School, and potentially, at a later date, the CBD. Preliminary feasibility analysis has been completed; further analysis is needed of the various supply alternatives and of ownership and financing arrangements.

Richmond, Indiana. The assessment identified several projects. One, in West Richmond, would transmit excess heat from the oversized boiler of a state hospital to several large greenhouses used for growing roses, a major energy-intensive Richmond industry. Although the supplier and users have expressed strong interest, a source for capital financing remains uncertain. Other longer-term projects, eventually to be consolidated with one another but not with the distant West Richmond system, would serve the CBD by cogenerating heat from the existing municipal power plant.

Springfield, Massachusetts. This project would involve retrofitting the Western Massachusetts Electric Company power plant to extract steam for distribution to the CBD and adjacent areas of the city. A refuse-fired plant [25] is being considered as a possible alternative or supplementary source. Ownership and financing arrangements have not yet been detailed.

PROJECTS FACING MAJOR OBSTACLES

This final category includes all remaining cities, i.e., those unable to identify feasible, near-term projects during the assessment phase. In almost every case the economic analysis showed unfavorable results due to (1) inability of district heating to compete f6r customers with lower-priced energy sources or fuels, (2) unavailability of a heat source for a district heating system, or (3) insufficient demand to justify the capital costs of building a district heating system. The emphasis here is on obstacles to near-term projects; with prices of competing fuels - mainly oil and gas projected to increase steadily, the ability of district heating to use alternative fuels, or to use conventional fuels more efficiently, may become more attractive later. Most communities in this category have committed themselves to maintaining a close watch on competitive fuel prices and to reconsider periodically the possibility of district heating.

In addition to those projects delayed for economic reasons, others are stalled for a variety of institutional reasons such as jurisdictional problems, public or political opposition, or simply failure to complete the work sufficiently to show conclusive results.

In several of the communities in this category, there are indications that analysis of other alternatives might produce an economically feasible project. Columbus, Ohio, is a notable example. Although assessment results indicate that the large system considered was not economically viable, further analysis could lead to configuration of a smaller initial project that could anchor a larger system to be developed in stages. The government of Denmark, Interested in promoting its district heating technology and equipment, will be providing Columbus with design assistance in the anticipation that a project could result. Section 7 (Obstacles to Project Success) discusses these projects in more detail.

CONTINUUM OF ASSESSMENT PROJECT RESULTS

Figure 3 shows the locations of the projects on a continuum that corresponds roughly with the hierarchy of decisions needed in the process of finding a feasible project. In general, feasibility decisions are made from left to right along the continuum; i.e,, decisions are normally made in approximately the order indicated as communities proceed from 'no project' to 'fully developed project."

It is important to note, however, that a project that appears stalled at a relatively early stage, e.g., needing to resolve technical issues, can make rapid progress once these issues are resolved.

Fig. 3 Continuum of Assessment Results

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Identify Possible Projects	Resolve Technical Issues	Resolve Economic Issues	Resolve Institutional Issues	Resolve Financing Issues	Determine Private Sector Interest	Prepare for Preliminary Design	Move to Final Design and Construction

Campbellsville	Bellows Falls	Cambridge	Allentown	Albany	Gary	Atlanta	Devils Lake
Missoula	Berlin	Columbus	Atlantic City	Galax	Norwalk	Baltimore	Lawrence
Santa Ana Pueblo	La Grande	Fort Wayne	Dayton	Holland			New York
		Ecorse	Thermopolis	Lewiston			
				Provo			
				Richmond			
				Springfield			

>>

Three cities have failed to identify possible projects: (1) Missoula, Montana, because of the lack of an environmentally acceptable heat source; (2) Campbellsville, Kentucky, because anticipated gas fields to fuel a district heating system have not been found; and (3) Santa Ana Pueblo, New Mexico, because further analysis is needed of the several alternatives presented for consideration.

Three communities need to resolve technical issues. Bellows Falls, Vermont; Berlin, Maryland; and La Grande all have identified geothermal sources for district heating and must now drill wells to determine whether the resource is sufficient in both quantity and heat content for use in district heating. Conditions in La Grande appear to be particularly favorable, and a project is likely to be built there if the resource availability questions are resolved and if a source of low-cost pipe can be found.

The four communities needing to resolve economic questions (Cambridge, Massachusetts; Columbus, Ohio; Ecorse, Michigan; and Fort Wayne, Indiana) have not yet been able to identify projects competitive with conventional, decentralized systems. Ecorse, however, is in a unique position; its project would serve a large, mixed-use development called Frenchman's Cove from one of two nearby power plants. Here, the issue is whether Frenchman's Cove will be developed and, if so, whether development will be at a rate sufficient to support investment in a district heating system within a reasonable period of time. If the project moves forward, heat will probably be supplied by . portable' thermal energy suppliers; when sufficient load is in place, the permanent district heating system would be installed. Cambridge is awaiting a decision by the steam company to determine whether expansion of the existing system is financially feasible. In four cities, institutional issues remain stumbling blocks. In Allentown, Pennsylvania, there is substantial political and public opposition to using refuse to supply heat to a district heating system,, although refuse may be the most economical fuel. Atlantic City, New Jersey, must resolve a jurisdictional issue over collection and ownership of its municipal waste. Dayton is awaiting a decision by Dayton Power and Light Company as to its interest in continuing operations at Tait Station, the planned thermal-energy supply source that is now scheduled for shutdown. And in Thermopolis, Wyoming, there is public opposition to use of nearby hot springs as a heat source because of fear that such use would interfere with tourism, important to the city's economic base.

For most cities, once the apparently 'doable" projects have been identified, the critical remaining issue is that of obtaining the necessary financing. This is true for seven of the 28 assessment cities. The nature of the financing issue is different among the various communities, however. In some, the key question is whether a financial package can be put together that will supply a sufficient return to investors, particularly during the first crucial years when the costs to users of district heating are higher than for conventional heating. But for some cities there is a prior question: where to obtain financing to conduct the detailed feasibility analyses and engineering designs that can determine whether an apparently feasible project can actually be accomplished. For many cities, even these relatively modest sums (in comparison to capital financing costs) are a burden in the face of severe budgetary constraints.

At least two cities have made an effort to resolve the problems of capital financing and feasibility analysis financing simultaneously by soliciting expressions of interest from private developers. Gary and Norwalk have done this on the assumption that if the initial assessment has indicated a favorable outlook, private entrepreneurs could be attracted to their profitmaking potential.

Preliminary project design is the step that precedes the securing of commitments for project financing. This includes what may be an extended process of preparing working drawings, negotiating to obtain financial and legal commitments from all parties involved, and obtaining needed permits toward preparation of construction specifications and letting of construction contracts. Baltimore and Atlanta appear to have reached this stage. it should be emphasized, of course, that especially in the present economic environment, arrival at the preliminary design stage is no assurance of success; many things can delay or even stop an otherwise feasible project, and some iteration between design details and financing can be anticipated.

The final stage is actual construction. Three of the 28 cities have reached this stage, all, as noted above, having had some steps under way before the assessment project began. In two of these cities, Lawrence and New York, early success has prompted commitment toward moving ahead on new or expanded systems.

5. PROJECT CHARACTERISTICS

The key characteristic of the projects identified by the 28 cities is diversity. Few commonalities emerge from the analysis; variables such as city size, location, energy or utility factors, or economic base do not reliably explain results of the assessment or the type of projects identified. As with other programs of this nature, each city represents a combination of unique characteristics that, in turn, help determine the nature of the results.

Table 5 presents selected characteristics of "most feasible' projects, i.e., those that were considered locally to have the best chance of being built. (Some cities identified more than one project.) The table indicates the wide diversity of the projects. Table 5 shows that a number of cities expect to start with relatively small projects and expand them in stages to encompass a wider area. These cities apparently recognize that it is important to get a system into operation and prove its cost savings and reliability in order to convince the broader market of its benefits. Most cities that planned staged systems proposed "anchoring" the initial system with several large users - schools, hospitals, apartment buildings, public buildings, a factory - and adding lower-density heat loads later. The concentrated heat loads of larger users also tend to minimize the costs of transmission pipe, an important capital component of the system.

Some cities also are planning several projects that may develop concurrently, eventually to be connected into a single large system. In Atlanta, for example, several downtown projects are proposed, each relying on a local heat source. Eventually, these and others could be consolidated into a single system that serves the entire CBD and surrounding areas, with base heat loads supplied by retrofitting a nearby electric generating plant for cogeneration. The assessment indicates a favorable economic outlook for this scenario even in Atlanta, which has the warmest climate of the 28 cities.

Other characteristics discussed are: fuel and distribution, heat sources, incorporation of existing infrastructure into projects, utility involvement, and ownership entities.

FUEL AND DISTRIBUTION CHARACTERISTICS

Table 6 presents the fuel and distribution characteristics of the principal projects. Most cities avoid use of premium fuels (oil and gas) to minimize the fuel cost component of the systems. The exceptions typically are now using oil or gas, and the district heating system would be based on excess existing capacity. There also is a strong tendency toward use of locally available energy sources such as coal or geothermal heat.

Hot water is the preferred distribution medium, although steam is used in a number of instances to minimize retrofitting costs for the end user. A few communities are considering hybrid systems that allow steam or, hot water to be supplied as needed by various customers.

HEAT SOURCES

The communities identified four types of heat sources for a district heating system: (1) municipal or agricultural waste for refuse-fired systems, (2) geothermal energy or groundwater, (3) cogeneration systems supplying both heat and electricity, and (4) boilers supplying heat only using a variety of fuels. This does not include projects whose fuel sources are uncertain.

Figure 4, derived from data in Tables 5 and 6, indicates the heat sources of the various projects using the available data. The categories overlap, e.go, a refuse-fired system could supply heat only or could cogenerate electricity along with heat.

This figure indicates that:

◦ Of 11 projects anticipating use of refuse as a heat source, 10 are probable early-start projects. This points up the benefits that cities can obtain by using refuse as a heat (and revenue) source rather than discarding it at a fee.

◦ Four cities have investigated use of geothermal energy. Three of these need to conduct further geologic investigations, including test drilling, to determine if the resource is available in sufficient quantity, and with a high enough heat content, to supply the anticipated demand. The high cost of such drilling is a major barrier for these smaller communities.

◦ Twenty-one of the projects anticipate cogeneration of electricity along with heat as away of enhancing their revenue base and improving the project's economic position.

· Relatively few of the projects expect to use heat-only boilers as a source of heat for a district heating system other than as an interim arrangement. At least five projects will expand on or modernize an existing boiler or district heating system, thereby gaining the benefit of capital already in place.

Table 5 Characteristics of Projects Considered Most Feasible

City	Probable Early Start Project Identified? Y/N #	Source(s) Likely	Staged?	Major Users	Probable Fuel	Heat only or Cogeneration	Comments
Albany	Yes 1	State-owned dist.htg.plant	No	139 housing units in Arbor Hill community devel. area	gas, oil peaking (alt. Possible)	heat only	Two additional long-term projects possible serving an institutional area and a commercial restoration.
Allentown	No -	New fluidized bed coal plant	Yes	CBD and industrial plants	coal; gas peakg	cogen	Alternative being explored
Atlanta	Yes 4	1.Existing total energy system 2.New diesel or heat only boiler 3.In-place steam 4.combustion turbine	Yes	-major office, convention facilities -World Congress Coliseum, offices -2 pub hsg projects, -state and civic center complex	gas gas gas, oil peaking gas	cogen gas heat only cogen	Intent is to eventually link these and other projects into a large system serving most of CBD and environs.
Atlantic City	No	New refuse plant	Yes	Casinos and nearby commercial	refuse	cogen	At least 5 possible projects identified - all requiring further study
Baltimore	Yes 2	Both: refuse incinerator (under construction)	Poss.	1.Cherry Hill, pub. and private hsg. hospital, schools 2.Hopkins/E.Balt, 2 jails, pub hsg , 5 schools, some res.	Refuse (gas as alt)	cogen	One project will use existing steam system lines, several expansion possibilities.
Bellow Falls	No -	Groundwater aquifer (distributed heat pumps)	Poss.	CDB commercial	geothml	heat only	Further drilling needed.
Berlin	Yes 1	Geothermal well	No	commercial and instit'l bldgs	geothml; existg electric plant for peaking	heat only	Further drilling needed.
Cambridge	No -	Extension of existing steam system	Poss.	Initially 2 hospitals	gas, oil peaking	cogen cogen	One of several projects being considered.
Campbellsville	No -	Coal boiler	No	1 industrial plant	coal (possibly refuse)	heat only	Gas field found inadequate.
Columbus	No -	Coal boile	Poss.	Ohio State U; part of CBD; mixed use areas between	coal; gas	cogen	Further study under way

Table 5 Characteristics of Projects Considered Most Feasible (continued)

City	Probable Early Start Project Identified? Y/N	No.	Source(s) Likely	Staged? Y/N Possible	Major Users	Probable Fuel	Heat only or Cogeneration	Comments
Dayton	Yes	1 (2 loops)	Existing elec generating plant	Yes	Initially hosp and comml users, then ind plants, pub hsg	coal, possibly refuse, gas later	cogen	Staged growth to encompass 2 heat islands initially
Devils Lake	Yes	1	Existing steam system converted from gas to refuse	No	CBD; mainly commercial, some residential	muni and agricultural waste	heat only	Conversion now under way.
Ecorse	No	-	One of two existing elec. gener. plants	Yes	Planned mixed-use development	coal (but using modular gas-fired units (initially).	cogen	Directly related to viability of Frenchman's Cove development.
Fort Wayne	No	-	Initially gas boilers; eventually power plant retrofit.	Yes	CBD and industry	Oil; possibly refuse later	cogen	Unfavorable cost competition
Galax	Yes	1	Incinerator	No	Hanes Underwear	Refuse; coal	heat only	City incinerator to supply industrial plant with process steam; exploring financing.
Gary	Yes	1	New incinerator	Poss	2 hospitals, part of CBD	Refuse	cogen	---
Holland	Yes	1	Munic. power plant retrofit	Yes	CBD, industry, Hope College expansion to hospitals and surround-res. and com'l areas.	Coal	cogen	Initial financing uncertain
La Grande	Yes	1	Geothermal	No	"Instit'l corridor" of civic bldgs, schools, hosp, state college	Geotherm'l	heat only	--------------
Lawrence	Yes	1	New incinerator	Yes	Paper mills, public housing, other residential	Refuse	cogen	System to be consolidated with industrial waste heat sources; likely expansion.
Lewiston	Yes	1	New incinerator	Poss	CBD environs; 2 large mills and adjacent residential	Refuse; oil-fired ind'l boiler for peaking	cogen	Will incorporate existing 2-industry system
Missoula	No	-	---	----	-----	-----	---	No project seriously considered. Lack viable source

Table 5 Characteristics of Projects Considered Most Feasible (continued)

City	Probable Early Start Project Identified? Y/N #	Source(s) Likely	Staged? Y/N Possible	Major Users	Probable Fuel	Heat only or Cogen	Comments
New York	Yes 4	1.gas/oil cogen boilers	Yes	Ind park/ public housing	gas/oil	cogen	Several projects may go independently.
		2.gas/oil cogen	Yes	Hospitals	gas	cogen	
		3.Incinerator	No	Pub.hsg, other resid'l	Refuse	cogen	
		4.Incinerator	Poss	City bldg, industry	Refuse	cogen	
Norwalk	Yes 1	Principally new incinerator	Yes	Process steam for ind; resid'l, institutional space heating	Refuse; oil	cogen	Staged development in nearby CBD
Provo	Yes 1	Power plant cogeneration	Yes	CBD, high school, hospital	Coal, refuse boiler	cogen	------
Richmond	Yes 1	State hospital boiler	No	Project 1: steam to greenhouse	Coal	heat only	Also considering cogen retrofit of municipal plant for areawide system.
Santa Ana Pueblo	No	-----	---	-------	Various being considered; methane most likely.		-----
Springfield	Yes 1	Power plant retrofit	Yes	CBD and environs	Planned conversion to coal; possible refuse/gas early	cogen	---
Thermopolis	Yes 1	Hot springs	Yes	Entire town	Geothermal	heat only	---

USE OF CAPITAL INFRASTRUCTURE

In addition to use of relatively low-cost fuels such as refuse and coal, another way a district heating system
can be developed economically is to incorporate it into the system capital infrastructure already in place. Table 7 distinguishes projects using such infrastructure from those that do not, by current project status.

Examples of such infrastructure include:

- An existing district heating system that may be upgraded, expanded, or connected with a new heat source.
- An existing boiler that may have excess capacity for distribution to other users.
- An electric generating plant that could be retrofitted to cogenerate heat along with electricity.
- An existing incinerator from which heat could be extracted (and possibly electricity as well) to supply a district heating system.

The evidence from Table 7 clearly shows the advantage of using existing capital infrastructure. Twenty of the probable early-start projects use existing infrastructure; only four do not. In Devils Lake, for example, the project involves modernization of an existing steam system and substitution of urban and agricultural refuse for coal. New York's Navy Yard project, now connected to a utility-supplied steam system, has installed portable gas boilers to lower heating bills by 25% with the intention of further expansion later, and Lawrence is adding new lines to transfer steam from a refuse plant now under construction.

Many projects will rely on existing hospital, industrial, university, or other large boilers either for base load or peaking power; these include Albany, Richmond, Provo, and Lewiston. Power plant retrofitting to cogenerate heat for a district heating system is quite common and is the proposed base load source, for example, in Dayton, Holland, Provo, and Ecorse.

Table 6 Fuel and Distribution Characteristics of Principal Projects Considered

City	Probable Fuel	Distribution Fluid	Distribution Temperature (°F)	Reason for Selecting Fluid/Temperature
Albany	Oil	Hot water	250	Extension of existing system
Allentown	Coal, gas	Principally Hot water	250(steam to certain industries)	Customer needs
Atlanta	1.Gas	Hot water	250	Existing system
	2.Gas	Hot water	250	
	3.Gas-oil peaking	Hot water	250	
Atlantic City	1.Refuse	Hot water	220	
	2.Refuse	Hot water	NDa	
	3.Ice pile (cooling)	Chilled water	33	
Baltimore	Refuse	Hot water	250	Most economical
Bellows Falls	Geothermal	Hot water	ND	Source temperature
Berlin	Geothermal	Hot water	200	Probable emperature of geothermal source
Cambridge	Gas	Existing steam, possibly retrofit to hot water	Prefer low-temp.water (140)	Compatibility with probable customers
Campbellsville	Coal	Hot water	ND	
Columbus	Coal	Steam	ND	Compatibility with probably customers
Dayton	Early start: coal	Steam	ND	Compatibility with existing system.
	Mature: coal, refuse	Hot water	250	Ease of distribution
Devils Lake	Refuse; straw-oil/gas peaking	Steam	ND	Compatible with existing steam system.
Ecorse	Coal	Hot water	250 or 340	Fluid temperatures available from two power plants.

Table 6 Fuel and Distribution Characteristics, (continued)

City	Probable Fuel	Distribution Fluid	Distribution Temperature (°F)	Reason for Selecting Fluid/Temperature
Fort Wayne	Oil; gas	Hot water	250	
Galax	Refuse	Steam	365	Needed by industrial user
Gary	Refuse	ND	ND	
Holland	Coal	Phase I: steam Mature: hot water	ND	Phase I: lowest cost to customers
La Grande	Geothermal	Hot water	180	Probable temperature of geothermal source
Lawrence	Refuse	Steam	ND	Most economical
Lewiston	Refuse	Steam	ND	Needed by mills
New York	1.Gas/oil 2.Gas 3.Refuse 4.Refuse	Hybrid hot water/steam Hot water Hot water Hot water	350	Most economical
Norwalk	Refuse	Hybrid: process steam and hot water for space heating	ND	Customer needs
Provo	Coal, refuse	Steam	350	Compatible with university and other user needs
Richmond	W. Richmond: coal Areawide: coal	Steam Hot water	ND 250	Needed by customers Most economical
Springfield	Coal (conversion from oil/gas); refuse	Hot water	250	Most economical
Thermopolis	Geothermal	Hot water	ND	Availability

a ND=no data

Figure 4 Heat Sources of Proposed Projects

	Ready for Construction	Ready for Preliminary	Near Term Potential	Major Obstacles Remain	TOTAL
Heat Source					
Refuse-Fired	2	2	6	1	11
Geothermal	---	---	1	4	5
Cogeneration	1	5	10	5	21
Heat Only Boiler	3	1	3	1	8
TOTAL	6	8	20	11	45

Table 7 Projects Using Capital Infrastructure

	Ready for Construction	Ready for Preliminary Design	Near-Term Potential	Major Obstacles Remain
Project Type				
Using Existing Capital Infrastructure	3	6	11	2
No Existing Infrastructure	--	1	3	9

Two cities that have integrated capital infrastructure into their plans have, nonetheless, been unable to configure probable early-start projects, both for uniquely local reasons. The Ecorse project has been planned---to use excess heat from one of two nearby power plants, one municipally owned and the other investor-owned. But development of the project itself, Frenchman's Cove, remains uncertain at present. In Columbus, which would rely in part on Ohio State University's campus system, the project has proven uneconomical to build as presently configured (although alternative designs are now being explored) because of the relatively low cost of fuels currently used in the service area.

Conversely, the Norwalk project is classified as ready for preliminary design and uses no existing infrastructure. Tied to construction of a new refuse-fired cogeneration plant, the project has a profit-making potential that has enlisted interest from a number of private developers.

Overall, communities able to incorporate substantial existing capital infrastructure into their district heating systems are likely to improve their chances for implementation.

UTILITY PARTICIPATION

Utilities can be important partners in a district heating project Their possible roles include owning or operating a system, selling steam or hot water to a system (either through an existing utility-operated district heating system or by retrofitting a power plant for cogeneration), or purchasing electricity from a privately owned or publicly owned system. Obviously, these categories overlap; a utility can participate in more than one way.

Table 8 indicates the various forms of prospective utility involveme,nt. Projects indicated here are limited to the probable early-start category because many of those with major obstacles remaining have not yet focused on particular forms of utility participation. Even among these projects, the data in a number of cities indicate only a preference rather than a commitment, based on data supplied by local observers.

The table shows that the most likely utility involvement will be through the purchase of cogenerated electricity. This confirms the point made above - that projects can enhance their economic viability by selling cogenerated electricity to a utility (or private purchasers). Such purchases are required under provisions of the Public Utilities Regulatory Policy Act and often under provisions of state utility laws as well. Utilities operating near capacity may find district heating systems a desirable way to increase the supply of electricity available for resale without having to build expensive plants solely for power generation - where firm power supply commitments can be obtained.

Table 8 Nature Of Utility Involvement, by Project a

Utility Type	Possibly Own	Sell Steam/ Hot Water to System	Purchase Electricity
Publicly Owned Electric	4	0	1
Investor-Owned Electric	0	1	6
Gas	0	0	0
Combined Gas and Electric	2	2	6

a Probable early-start projects only.

In four cities - Holland, Provo, Devils Lake, and New York a publicly owned utility is being considered as owner of a district heating system. In New York, the state power authority is considering part ownership of a refuse-fired cogeneration plant; in Devils Lake, the steam system will be operated by a reconstituted, city-appointed steam heat authority.

PROJECT OWNERSHIP

One of the more difficult questions to resolve is that of ownership of a district heating system. This question is inextricably linked to financing arrangements, because ownership will usually be determined by the kinds of financial benefits available.

As indicated by Fig. 5, at this stage in project development the cities have identified a wide variety of ownership forms. Few have made firm decisions; several have not yet dealt with the ownership question because prior questions remain unresolved. Many of the cities' final reports offer alternative arrangements for consideration, describing the advantages and disadvantages of public and private ownership and various combinations.

Although present information is speculative, municipalities clearly expect to be sole or part owners of many of the district heating systems. On the other hand, at least four cities anticipate sole private ownership: Gary and Norwalk, which are seeking bidders at present; Baltimore, where the district heating system will be linked to an incinerator now under construction by a private firm under public license; and New York, where a private firm is considering financing the Kings County Hospital systems under a leasing agreement. Joint city/state public power authority ownership is being contemplated in one of the New York projects, while Lewiston is considering the creation of a new public authority to own and operate the system. It is important to note that many of these arrangements appear to be the preferred approach at 'this stage. Most cities are willing to consider other alternatives that may be more advantageous. One point on which all of the communities agree is the need to retain- qualified legal and financial counsel as soon as a serious proposal for a major capital project is developed.

Figure 5 Anticipated Ownership Entities.

Type of Ownership	Percent of Entities
Municipal	35%
Private	15%
Joint Private/City	15%
Public Authority	5%
Joint City/Public Authority	5%
Joint City/Public Power Authority	5%
Investor-Owned Utility	5%
Uncertain	15%

Finally, out of this initial assessment have emerged numerous opportunities for establishing joint private-public partnerships. The possible permutations and combinations run the gamut, e.g:

- Sole private ownership and operation of a system (Norwalk, Gary).
- Private ownership of the plant and public ownership of the transmission and distribution system (Lawrence, Baltimore).
- Joint ownership and operation of the system (Columbus).
- Creation of a nonprofit corporation to own and operate the system (Devils Lake).
- Electric utility provides regenerated heat to a publicly owned system (Ecorse, Fort Wayne).

Additionally, in most of the cities the private sector participates heavily as prospective customers, many of whom have already provided firm commitments for connection to the system when it is built. Such long-term commitments from large users are often an essential determinant of project success.

6. PARTICIPATION IN THE ASSESSMENT: THE ROLE OF ASSESSMENT WORK GROUPS

The process of deciding whether to develop a district heating system in a city is necessarily participatory. Such a system is a ma or capital project involving heat suppliers, transmission systems, and end users, often with complex financial, legal, and political questions to be resolved; thus, many community interests must be included along the path from the idea to the reality. The difficult question is how to find the vehicle to assure that all the appropriate parties participate in a logical, coordinated way and that their views are accommodated and decisions are made expeditiously.

In recognition of these needs at the outset, the cooperative agreement between HUD and each city required the establishment of a local District Heating Assessment Work Group (AWG), comprising representatives of key public and private interests, as the project oversight body. The way these groups functioned and changed during the course of the year-long project offers some lessons of value to other cities contemplating a similar effort.

AWG PARTICIPANTS

The AWGS, as initially constituted, were typically broad-based, large bodies with about 8 to 35 members. Almost all were especially created to oversee the district heating assessment, although in at least one instance
Atlantic City - the AWG included all 11 members of the existing CDBG Citizens Advisory Board.

Actual involvement, as measured by meeting attendance and level of participation, was significantly different at the end of the assessment in many cities than at the beginning, as reported by local observers. The high level of interest and meeting attendance exhibited at the outset tended to wane so that at the conclusion of the assessment process a smaller working group remained.

Those who remained active participants typically represented interests likely to be directly involved in a project as suppliers of heat or as users, owners, or operators. More specifically, the roles of the following tended to predominate:

City Government. City government staff and political leaders took the lead role in virtually every assessment city, not only because they were the recipient of the funds under the cooperative agreement but because they recognized the community benefits that could accrue. In some cities, the personal interest and commitment of a leading political official was instrumental in maintaining interest and momentum. Mayors Lawrence LeFebre of Lawrence, James Ferguson of Provo, and Winfield Moses of Fort Wayne, and Commissioner Patricia Roach of Dayton all played direct and continuing roles. City government interest tended to be especially great when the city was likely to be [42]directly involved in a project ' as, for example, where a contemplated refusefired system could solve a landfill problem, where a city-owned power plant was a candidate for cogeneration, or where city buildings or a redevelopment project were likely end users.

Utilities. The role of utilities, both municipal and investor-owned, was highly variable. Virtually every AWG included representatives from each of the utilities, and most were regular meeting attendees, although their level of participation tended to be directly related to their anticipated project role.

Although it is difficult to draw firm conclusions, some generalizations can be made:

- Electric companies typically were more involved in deliberations than were gas companies. In a few instances, gas companies voiced opposition to proposed district heating systems because the companies anticipated the loss of gas heating customers. Electric company representatives, because they anticipated little effect on their loads, often served as "technical" AWG members, reviewing and commenting on working papers and presentations.

- Some combined electric and gas companies were highly supportive. Baltimore Gas and Electric supplied significant amounts of data and lent valuable technical support to the assessment. Northeast Utilities, serving both Norwalk and Springfield, participated actively in both studies; in Norwalk, the company conducted a detailed study of the potential for retrofitting its power plant for cogeneration, as a major contribution to the assessment. In Gary, Northern Indiana Public Service Co. supplied important data and technical review of consultant and staff reports.

- The role of existing district heating companies can perhaps best be described as "standoffish" (a term used by one local observer). District heating systems typically represent only a small part of the rate base of a company whose business consists primarily of supplying gas and/or electricity, as in Atlanta (Georgia Power Co.), Dayton (Dayton Power and Light), Cambridge (Cambridge Steam, a subsidiary of Cambridge Electric), and New York (Consolidated Edison). In each city, some or all of the existing system was considered for inclusion in an expanded district heating system and each of the companies remains unsure of its future interest in continuing to operate the system. Alone among such companies, Baltimore Gas and Electric, which in addition to supplying gas and electricity also operates a CBD steam system, was deeply involved in the assessment process.

- Finally, in the relatively few assessment cities that operate municipal utilities, the utility role was central. In Holland, Norwalk, Provo, and Richmond, prospective projects all considered extracting waste heat from municipal power plants, although final results varied. Utility staff members were deeply involved in analytical work, doing studies, and contributing technical oversight and - in the case of Norwalk - additional funds.

Two additional examples are worthy of mention. In New York, the Power Authority of the State of New York (PASKY) has studied the Southwest Brooklyn Incinerator Project, concluding that the capital cost of retrofitting the incinerator would be half the cost of building a new power plant with equivalent capacity. The active support of PASNY for the project is considered a significant benefit to implementation. And in Ecorse, Detroit Edison has played an active role in the assessment process and has offered to supply cogenerated hot water from its nearby River Rouge generating plant.

<u>Business and Industry</u>. Business and industry representatives, too, were involved in proportion to their potential for direct participation in a project, as either suppliers or users of heat. A few cities view district heating as a major component of their economic development strategy, including helping to maintain industrial jobs and commercial business by supplying lower-cost heat or process steam. In such instances, business involvement was substantial.

Both the Campbellsville and Galax systems, if built, would serve their cities' largest industries; in both instances, company participation has been central. Richmond is similar; a proposed early-start project would supply :steam to rose-growing greenhouses, a major Richmond business that has been seriously affected by fuel prices. In older industrial cities such as Dayton, Fort Wayne, Allentown, and Norwalk, industry's participation by providing heat purchase commitments and, in some instances by supplying base load or peaking heat, has been essential to move the project forward.

Cooperation by business in supplying heat load information and similar data was almost uniformly good. Collecting such data was an early step in the initial configuration of heat islands and sources that helped in the selection of potential projects. Many cities prepared questionnaires; response was excellent and few companies balked at supplying these often proprietary data. Beyond the assurances of confidentiality that were given, it seems evident that there was widespread recognition of the benefits of district heating, and thus a strong incentive to cooperate.

In general, representatives of such other interests as developers, the financial community, and environmental and community groups - together with the public - played a smaller role-in the assessment process. Although invited to participate as members of AWGS, these individuals generally stop attending after a few meetings. This, again, is directly related to how they saw themselves affected by a project.

Most projects initially will serve a few large "anchor" buildings, expecting to grow later by serving more dispersed properties, often residential and commercial. Having little direct interest, therefore, members of the public often saw little reason to participate. Developers or other real estate interests were involved in those few projects that anticipated serving new developments. And members of the financial community - bankers, underwriters, etc. - though recognized by project leaders as critical to success, also tended to lose interest in what they perceived to be principally technical analyses at this stage. 'Call me later when you have begun to think seriously about a project" was a commonly expressed theme. That theme is perhaps the one that generally characterized the assessment effort and the role of the AWGs in it.

ROLES OF THE AWG

Each Assessment Work Group performed multiple project roles. Early in the assessment, the principal objective was to determine whether conditions existed locally that could lead to one or more viable district heating projects. Given this objective, most of the projects were decidedly technical in nature, and the AWG served principally a supervisory role.

overall, local observers report that key project leadership came from technical staff and consultants. Almost all the cities employed consultants, either a single firm to do all the work under the cooperative agreement or several consultants to do more specialized tasks. City staff maintained dayto-day contact (or, as in a few cities, carried out some data collection and analytical studies).

Once the work plan was fixed and the consultant contract signed, AWG meetings in most cities became less frequent. When the AWG did meet, however, it was often to make an important decision based on the alternatives presented by staff/consultants. For example, a working paper might be presented showing the location of "heat islands," i.e., concentrations of facilities with high heat demands and possible heat sources to serve them. AWG deliberations would lead to a decision to focus on selected areas either singly or in various combinations.

The major role of the AWG, of course, came after the technical work was completed in making the final advisory decision of whether to proceed to a more detailed level of analysis and with what (e.g., with a small system or with a larger one). A specific vehicle for such decisions was HUD's Request for Cooperative Agreement for a Phase II feasibility assessment.

In a few instances, AWGS. helped to configure projects that had not initially been investigated in the technical analysis (as in Cambridge), or conversely, to remove from further consideration those projects that, while considered technically sound, failed institutional/political tests. In one city, for example, project leadership was unwilling to consider tying the district heating system to an ongoing incinerator project that had gone over budget and forced a tax increase, fearing that community resentment of the earlier project would unnecessarily burden the district heating project. In each of these cities, the AWG role was instrumental in reflecting community sentiment about the kinds of projects that could be implemented.

Less directive but nonetheless significant activities included the following:

<u>Data Collection</u>. AWG members aided the data collection effort not only by supplying data for their own firms or institutions but also by contacting others to seek their support. As one example, Allentown's Center City Association, a merchant's group, was supportive of the data collection effort.

<u>Building Community Support</u>. Although many communities did not feel a need to enlist wide community support for district heating at the assessment stage, in several cities AWG members presented the process at meetings of other groups to inform and educate them. In addition, through participation in the AWG of prominent local individuals such as political leaders, major industrialists, and college presidents, the project was vested with prestige and credibility. This participation was seen by some local observers as helping the work move forward.

In sum, the composition and functioning of assessment'work groups were highly variable. Nonetheless, some general conclusions can be drawn:

- Many AWGs may initially have been unnecessarily large. Whether correctly or not, some individuals who were asked to serve saw the assessment primarily as a technical process that had little direct interest to them. An alternative approach could be the establishment of a small working group composed of those with special technical expertise and those with special interest in the results, while keeping others informed of progress.

◦ Members should have reasons to attend meetings. Meetings called only to receive a progress report, with no real opportunity for giving direction, can dissipate the interest of even the most interested individual.

◦ Information should be supplied in form and language understandable to participants. Some observers reported excessively technical presentations that were above the heads of some participants.

◦Where potentially controversial issues may emerge, it is important to maintain communication with those who are most interested, even if they do not actively participate in the AWG deliberations. A mayor opposed to a particular approach, a utility company unwilling to serve as a heat source or a company uninterested in anchoring a system can diminish or even preclude chances of success. Keeping lines of communication open may help change opposition to neutrality, if not to active support.

Finally, in virtually all the cities planning to move ahead with their projects, with or without additional federal support, local observers reported that the AWGs would continue to exist as the oversight body. In many such cases, there were plans to'augment the existing membership with specialists in legal/regulatory issues and in finance, essential skills that would be needed as projects move closer to design.

OBTAINING PUBLIC SUPPORT

The AWGs served as the principal vehicles for enlisting the public support deemed important in each community. But cities used a number of other means to educate the public about the benefits of district heating and to assuage misgivings (even, perhaps, on the part of some AWG members).

Market Analyses. At least two cities conducted market analyses in areas considered for district heating service. In Columbus, representatives of many -neighborhood organizations were contacted regarding district heating potential and perceived effect on neighborhoods. Meetings were held to ,discuss these topics. The report indicated a favorable reaction, provided that the system is affordable to low- and moderate-income residents. A questionnaire distributed with residential water bills in Thermopolis elicited a generally favorable response, although residents do not want the local hot springs to be affected.

Most cities, however, saw little need to conduct formal market analyses or even informal attitude surveys because their proposed systems would initially serve only large users, all of whom were members of the AWG or from whom data had been secured. As systems expanded to serve more dispersed loads, all were likely to conduct market analyses - particularly those cities whose economic analysis assumed complete, or almost complete, market penetration in the service area.

Media Coverage. -Although some of the project staffs tried to secure media coverage through such means as press releases and preparation of press kits, few had much success. Announcement of funding awards often was considered newsworthy, but little other coverage was given until the results were reported; the exceptions were Gary, Atlanta, and Devils Lake. It is important to emphasize, however, that the information supplied by local [47] observers preceded the public hearings that were more likely to receive news coverage. One interesting sidelight, again in Thermopolis, was the appearance by the project leader on a local call-in talk show, which elicited some interesting comments from listeners.

Tours. Because district heating technology is generally unfamiliar, some project leaders organized tours to comparable facilities to demonstrate operations and allay possible concerns. Gary's AWG visited Chicago's Northwest Incinerator and Notre Dame University's district heating system; members of the Santa Ana Pueblo AWG traveled to Los Alamos, New Mexico, and Lamar, Colorado, to see demonstrations of active and passive solar energy systems, geothermal developments, and a biogas generating plant; and members of La Grande's AWG toured the geothermal district heating plant in Boise, Idaho.

Leadership Support. As noted above, participation and support by prominent public and private leaders - in effect providing "testimonials' for district heating - has lent the project credibility that may be capitalized on later.

Public Hearings. As a condition of the cooperative agreement, each city was hold a public hearing to obtain response to the proposals. Based on the little information reported, attendance and interest at hearings was uneven and generally low.

SUMMARY

Overall, it appears that those interest groups or individuals needing to participate in the assessment did, in fact, participate. The communities recognized, however, that projects planning on serving smaller residential and commercial buildings will need to invest more heavily in public information and education campaigns to obtain more direct participation from the public in later stages. Serious marketing efforts will be needed if multiple customers are to be served.

7. OBSTACLES TO PROJECT SUCCESS

Although Phase I of the assessment has demonstrated the widespread appeal and economic viability of district heating, many obstacles stand in the way of these very complex enterprises. Cities are at different stages in dealing with these issues: some have removed virtually all barriers and are well on their way toward construction; others are in the process of doing so; for the remainder, some barriers have proven insurmountable, i.e., these barriers have become 'project-killing' factors.

This section presents some of the important issues that a community must resolve along the way to building a district heating system. The potential obstacles covered here include:

- Availability of economically competitive heat sources.
- Environmental and regulatory issues.
- Public and political concerns.

AVAILABILITY OF ECONOMICALLY COMPETITIVE HEAT SOURCES

Configuration of a project usually starts with an analysis of heat sources and demands. This includes (1) collection of data on fuel and heat demands in potential service areas and (2) analysis of all existing and potential sources of thermal energy such as electrical generating plants, incinerators, building boilers, and industrial process equipment. The result of this inventory usually is a preliminary configuration of "heat islands" (areas of sufficient heat density to warrant further analysis) and a set of preliminary heat sources (suppliers who have, or could have, more heat available than they need or use).

Partly on the basis of these data, a preliminary economic analysis can be performed to determine whether district heating could more economically serve the heating needs of the area than do decentralized systems now n use. Major variables in the analysis include:

- Existing energy sources and their present and projected costs.
- Potential energy sources and costs.
- Distance between heat sources and users (piping costs).
- Costs of retrofitting existing thermal sources or constructing new sources.
- Current interest rates.
- Desired profit margin, if any.
- Availability of existing district heating systems or other capital infrastructure.

Numerous models have been designed to consider these variables and calculate such figures as annual capital costs and system maintenance costs over a specified period, e.g., 20 years. ANL's District Heating Strategy Model, which was- used by requesting communities, provided some baseline data for use in the economic decision making. Similar calculations were performed, by consultants or staff, often using proprietary models. As a working guide, a number of the communities used the ANL report District *Heating from Electric Generating Plants* and *Municipal Incinerators: Local PLanner's Assessment* Guide (by W.P. Pferdehirt and N.F. Kron, Jr., ANL/CNSV-12, November 1980).

The "bottom line" of this analysis addresses the question 'Is the price of delivered energy from a district heating system lower than that of conventional sources, now and in the future?' if the answer is negative, there will be of course no incentive for potential customers to switch. As a result, for the purpose of conducting an economic analysis, the assessment typically assumes a price of delivered energy from a district heat supplier lower than that of competing sources, say 80% of conventional costs. If the economics are favorable at that assumed price, the difference is likely to be great enough to overcome the natural reluctance of end users to tie in to the district heating system.

As pointed out in the economic analysis section in the technical companion to this report,* almost all the cities were able to configure projects that met preliminary economic feasibility tests. That is, by charging competitive delivered-energy prices, a district heating system would generate sufficient revenue to cover annual costs of debt service, fuel, and operation and maintenance. In Campbellsville and Missoula, however, the lack of suitable economic heat sources became "killing factors."

In Campbellsville, the cooperative agreement provided the funds for the analysis of local gas wells, gas and coal-fired boilers, and groundwater utilization through water-to-air heat pumps. The analysis indicated that there is little likelihood that significant quantities of natural gas underlie the city at a shallow depth. Thus, the possibility of a gas-fired boiler for the district heating system was virtually eliminated. The relative costs of both coal-fired and groundwater systems are anticipated to be higher than natural gas even, after deregulation in 1985. But discussion is continuing between the AWG and industrial representatives on the possibility of developing a community-owned coal-f ired boiler system to meet industrial energy demand; this would be the first phase of a system that would eventually expand. Thus, while initial expectations were not realized, the assessment focused attention on new and more promising opportunities.

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*Kennedy, A.S., and J.F. Tschanz, *District Heating and CooZing: A 28-City Assessment - Technical and Economic Summary,* Argonne National Laboratory Report ANL/CNSV-TM-119 (1983).

Missoula's analysis identified possible heat loads, but found no heat source that is economical or environmentally acceptable. Missoula suffers from severe winter temperature inversions, which rules out the use of the most plentiful fuels - wood, coal, and urban waste - because of high particulate emissions. Alternative resources were unavailable or uneconomical. As a result, the AWG determined that no district heating system could be built in the foreseeable future and shifted its focus to a broader community-wide conservation program.

These two communities, along with Santa Ana Pueblo for other reasons, were the only ones of the 28 participants that were unable to identify potential projects because of unique local conditions. Although the killing factors are identified as technical, i.e., the unavailability of heat sources, the real issue quickly translates into one of economical heat sources. Even in Missoula and Campbellsville, further increases in the prices of comp etitive fuels could, in a few years, create an environment more conducive to district heating.

In cities considering geothermal heat sources, prospects have improved in recent years as technologies have become available and prices of conventional fuels have risen. Although conditions for geothermal heat as an energy source are particularly favorable in parts of the northwestern U.S., opportunities exist in other areas of the country as well. Four of the assessment cities - La Grande, Thermopolis, Bellows Falls, and Berlin - focused on geothermal opportunities with different results. Interestingly, these were among the smallest communities participating; all have populations under 10,000.

One issue dominates the prospects for district heating in these four communities: although heat loads are small, they appear sufficient to justify a district heating system, but uncertainty remains about the temperature and quantity of the water in the aquifer. Further test drilling is needed, but speculative drilling is risky and expensive, and the Money is not readily available in these smaller communities. Thus, each community has identified a viable project if test drilling can be done and the results are favorable. The prospects in La Grande for a project are somewhat more favorable than in the other three communities because sources of financing, principally private, appear promising.

Price competition has dimmed the prospects for district heating in two other cities, at least for the projects conceived during the assessment process. These are Columbus and Fort Wayne; in both cases, availability of relatively low-cost fuel eliminates the near-term incentive to Invest in a new district heating system.

The Columbus study was able to identify a system that might be economically viable if built in about a decade, based on projected fuel costs. The service area would include Ohio State University (which has its own district heating system), a portion of downtown that is served by a stateowned district heating loop, and some residential, commercial, and industrial areas. It would use a variety of heat sources: coal-fired cogeneration, a new coal-fired boiler, gas-fired peaking boilers, and excess capacity from existing coal-fired industrial boilers. The economic consultant computed the ratio of the cost of energy from current means to the cost from the district heating system; not until 1995 would district heating become competitive. As noted earlier, subsequent interest has been expressed in a smaller, less ambitious system initially, with somewhat brighter prospects. The Danish government is supplying technical assistance to Columbus to explore these additional opportunities.

In Fort Wayne, similar results were achieved from the assessment. Of a number of scenarios developed, the CBD and the East End industrial area were identified as having the greatest potential for development of a hot water system, with the CBD having higher priority. The CBD system would be developed in stages starting with a seven-block island and progressing to an areawide downtown system. Four heat sources were considered: excess heat from an industrial boiler; cogenerated heat from a presently deactivated, privately owned electric turbine; a privately owned waste-to-energy system; and a municipal, energy-producing solid waste incinerator. In each case, the potential revenue to be generated was determined to be insufficient to amortize the initial capital investment because conventional fossil fuel heating systems would hold a favorable market position into the foreseeable future.

The Fort Wayne AWG, however, is committed to forming a small committee to meet periodically, monitor future conditions, and be prepared to reopen consideration of district heating should conditions appear more favorable.

In sum, several cities have identified the lack of an economically competitive heat source as an insurmountable obstacle, at least over the short term. Perhaps most interesting, however, is that relatively few cities have given up on the potential for district heating. The assessment has not "killed" the prospects in many cities; rather, it has identified possibilities that, while not necessarily imminent or even those expected at the start of the assessment, are sufficiently attractive to warrant continuing attention.

ENVIRONMENTAL AND REGULATORY ISSUES

Environmental and regulatory issues were given relatively limited attention as potential barriers to district heating systems. A number of the assessment reports discussed issues, problems, and approaches, indicating that problems that might be found would need to be further explored in Phase II. Thus, relatively little data on these topics have emerged from the assessment.

At the somewhat superficial level of analysis, almost every community arrived at a similar conclusion: if the economic analysis showed a strong potential for a district heating system, the terms of environmental and other federal, state, and local regulations could probably be met. Only in Missoula and Thermopolis were serious environmental issues raised.

Missoula is a nonattainment area for particulates, and winter atmospheric conditions preclude the burning of additional coal or municipal refuse, the only economical fuels for district heating. A number of other communities considering refuse burning indicated a need to deal with the particulate emission problem in the construction of a plant.

Thermopolis identified at least two potential geothermal sources; if hot springs are used, drawdown may cause nearby land subsidence; if wells are used, the wastewater may need to be treated, especially if reinjected, to ensure maintenance of water quality. Of the geothermal cities, all but La Grande raised similar concerns.

Atlantic City has developed a proposal for creating an ice pile in the winter to be used for cooling casinos in the summer. A fog would hang over the pile, but this is considered to be only a nuisance rather than a serious problem.

In virtually all other instances, the analysis confirmed widespread earlier evidence that substituting a central system for older in-building decentralized systems would incorporate state-of-the-art air pollution control technologies and thereby improve air quality. In one instance, Gary requested a pollution analysis of its proposed system from the cityls Air Pollution Control Board; the findings indicated that the system would not adversely affect air quality.

The possibility that other governmental regulations might preclude the establishment of district heating systems was investigated in the assessment in much the same way as were the environmental issues. Previous studies have identified numerous regulations at the federal, state, and local levels that would need to be complied with - or changed - before a district heating system could be built. An important issue is whether district heating would fall under the jurisdiction of state public utility commissions (PUCS) in regard to rate-making, service areas, and equitable cost allocation if the system were to provide more than one utility service (such as both electricity and heat). State regulations vary considerably in their treatment of these questions, and this treatment has been an important determinant of proposed ownership arrangements.

Many states require regulation of thermal service rates by PUCs when these services are supplied by regulated public utilities, which are usually investor-owned. Especially in the case of cogeneration systems, utilities generally appear to prefer to supply heat only - at the boundaries of their plant site and not to deliver to end users. Depending on local law, this might avoid the need for formulas to allocate costs among electric and heat customers.

Conditions are different for nonregulated utilities (publicly owned) because their nonprofit status assumes that rates are determined on the basis of service costs. Nonetheless, rate complications arise when thermal services are provided outside existing service areas.

The cities approached these regulatory questions differently, reflecting not only variations in regulations but also differing perspectives. Some states, as for example, Maine, encourage energy production from alternative sources or renewable resources as a matter of public policy. This policy has the effect of exempting small power producers and cogenerators from the usual PUC procedures of energy facilities siting and rate setting, except that the exemption is withdrawn if 50% or more of the small power producer or cogenerator is owned by a public utility. Thus, assuming that avoidance of PUC regulations would be advantageous to its project, Lewiston's ownership proposals limited utility ownership to less than 50%.

Public policy in Indiana similarly encourages small power producers and cogenerators. But the Gary AWG indicated its preference for private ownership (which could include a utility company) and acceptance of PUC jurisdiction as a means of assuring consumer protection and building public confidence. As in other states, Indiana's regulations with respect to district heating are unclear; Gary, therefore, has formed a coalition with the other two Indiana assessment cities, Fort Wayne and Richmond, and has begun working with members of the PUC to examine current provisions and the possible need for modification.

Much state legislation in this area has been modeled after the federal Public Utilities Regulatory Policies Act of 1978 (PURPA) which, among other things, streamlines the application procedures for small power producers and requires utilities to purchase electricity from small power producers at the utilities' avoided cost.* The effect is to allow such producers to sell electricity without being subject to the complicated utility regulations; producers are also guaranteed a market for the electricity they generate. As noted in Section 5, a number of district heating projects anticipate cogenerating electricity for resale, either to utilities or elsewhere, to help enhance their revenue base and improve project economics.

*PURPA regulations define *avoided costs* as "the incremental costs to an electric utility of electric energy or capacity or both which, but for the purchase from the qualifying facility or qualifying facilities, such utility would generate itself or purchase from another source."

In Baltimore, the AWG determined that the best approach would be ownership of the system by a limited partnership, i.e., the Baltimore Refuse Energy Systems Company (BRESCO), of which Wheelabrator-Frye, Inc., is the managing partner. BRESCO is under contract from the Northeast Maryland Waste Disposal Authority to design, build, own, and operate the incinerator that is the heat source for the proposed system. If BRESCO could not own the system because of the assertion of rate regulation jurisdiction by the state PUC, the Authority - which is exempt from such jurisdiction - would probably assume ownership. Under those circumstances, the presently proposed financing scheme would require restructuring.

Massachusetts legislation enacted in 1982 (supported by the city of Lawrence) exempts cogeneration facilities and small power producers from state regulation. This was important to the success of the Lawrence project because it authorizes the retail sale of electricity in an industrial park that existed before March 1, 1982, and where electricity generating capabilities existed before that date. The effect here was to allow the system to sell electricity directly to industries in the Arlington Mills complex, thus lessening the project's risk and improving its attractiveness to lenders.

Finally, in Bellows Falls, discussion of the uncertainties and complexities of regulation and ownership has led to initial agreement on the need to develop model legislation to cover district heating services under various ownership arrangements. A member of the state legislature has been serving on the AWG and has expressed interest in working to develop such legislation.

Two conclusions emerge from the relatively cursory reviews that the cities have given to possible regulatory impediments. First, few expect existing regulations to prevent construction of district heating systems. But second, the existing regulatory structure does not address district heating issues with sufficient clarity to be certain of the best approaches in a given situation. It appears that the time is ripe for a serious national review of the effect on district heating systems of public utility regulations, with the objective of establishing a clear public policy.

PUBLIC AND POLITICAL CONCERNS

A number of cities identified projects that appear to have passed technical, economic, environmental, and regulatory tests, only to be delayed or virtually stopped by public or political opposition. Opposition can arise for many reasons and often has more to do with perceptions of possible problems than with actual problems. This opposition is nonetheless real and significant, and it demands response from an AWG or its equivalent if a project is to proceed.

Some of these problems have led to the scuttling of particular project concepts; others have led to reformulation of project designs or ownership and financing arrangements. By their nature, issues evoking public or political concern tend to be a mixed lot and defy easy classification. A few examples may be instructive.

- One northeastern city initially considered refuse as a system heat source.' Opposition by the mayor to burning refuse within the city, because of previous odor problems from a sewage treatment plant, precluded further consideration of this source.

- At least two cities (Lawrence and Baltimore) are now building incinerators that have been determined to be the best heat source. Another city, similarly situated, is constructing a refuse-burning power plant that would have supplied the lowest-cost thermal energy. But that city has experienced cost overruns and construction delays that will require the raising of either the property tax or the' income tax. The AWG perceived that negative community feeling toward the plant would inhibit acceptance of district heating if it were linked to the power plant. Other sources have therefore been explored.

◦ Another city was willing to consider only private-system ownership because the mayor feared repercussions if winter heat were to be cut off for nonpayment of bills.

◦ One of the communities considering geothermal energy ran into opposition from members of the public who feared interference with the nearby hot springs, a prime tourist attraction.

◦ One senior city official expressed serious reservations about a proposed coal fluidized-bed-combustion system out of concern that the city could not adequately manage a new and sophisticated technology.

These concerns reflect a general lack of familiarity with district heating on the part of the public and many governmental officials. They are voiced not only in these kinds of specific concerns but more generally in the question of whether a community should use its limited capital resources to finance a district heating system or other, competing projects. Without expressing direct opposition, some city officials have been apathetic toward district heating when they believed that there were many more serious problems needing attention.

It would appear, therefore, that strong political or community support may not be needed for a system that has profit-making potential and will be supplier- and/or user-financed. But a system needing governmental involvement can be stopped by strong political or public opposition. Education of the public and especially governmental leaders may be needed at least to allow district heating to become familiar enough to adequately compete for public investment dollars.

8. COMMUNITY BENEFITS OF DISTRICT HEATING

Up to this point in the presentation of the assessment findings, attention has focused on district heating 'projects," i.e., the technical, economic, institutional, environmental, and other factors that determine whether a system has potential in a particular city. But merely because a project is judged to be feasible is not necessarily sufficient reason to pursue it. Rather, its investment potential must be determined on the basis of possiblebenefits and compared with alternative investment opportunities. In turn,, these benefits are more than financial; to compete for public dollars, projects must demonstrate additional economic and community returns.

These benefits represent the public "bottom line," which is why the federal government funded this series of assessments. If district heating can be shown to support other public policy objectives related to community and economic development, as well as provide a savings in dollars spent on scarce or imported fuels, district heating may warrant support.

This section addresses the degree to which the communities may benefit from district heating projects. The following topics are covered:

- Capital investment in projects.
- Economic and job benefits.
- Community and economic development objectives.

Table 9. Capital Costs of Projects

City	Project Name	Capital Cost (1982 $1000)
Albany	Institutional Loop	53,850
Allentown	Downtown Project	96,928
Atlanta	1. Peachtree Center	8,356
	2. World Congress Center	6,408
	3. State Office Tower	4,114
	4. South CBD	9,047
Atlantic City	Marina Cove	5,170
Baltimore	1. Cherry Hill	12,959
	2. Hopkins/East Baltimore	7,587
Bellows Falls	Geothermal	2,102
Berlin	Geothermal	2,468
Cambridge		ND
Campbellsville		ND
Columbus	Ohio State U./CBD	238,700
Dayton	St. Elizabeth/Delco	156,400
Devils Lake	Steam Plant Conversion	2,400
Ecorse	Frenchman's Cove	7,500
Fort Wayne	Ultimate System	11,400
Galax	Hanes Underwear	1,557
Gary	CBD/Incinerator	65,000
Holland	Power Plant Retrofit	14,300
La Grande	Institutional Corridor	6,790
Lawrence	Refuse Incinerator	95,645
Lewiston	Refuse/Cogeneration	14,841
Missoula		ND
New York	Navy Yard	1,400
Norwalk	Incinerator	15,000
Provo	CBD/Brigham Young U.	59,950
Richmond	1. West Richmond	644
	2. Areawide/CBD	28,192
Santa Ana Pueblo		ND
Springfield	Downtown	27,664
Thermopolis	Geothermal	15,750

ND = no data.

Table 10 Summary of Project Capital Costs (1982 dollars) and Reported Cities and Projects

Item	Ready for Construction	Other Early-Start	Major Obstacles Remain
Capital costs ($1000)	99,445	410,617	462,060
Average per project ($1000)	33,148	25,663	46,206
No. of cities reported	3	12	10
No. of projects reported	3	16	10

CAPITAL INVESTMENT IN PROJECTS

. Table 9 shows the total capital costs (1982 dollars) of those projects for which information is available.* These data, in turn, are summarized in Table 10 in three categories: ready for construction, other early-start projects, and those in which major obstacles remain.

[These data have been obtained from project data forms that represented an effort by ANL to obtain data about the cities' projects in a uniform reporting format. These were completed initially by local project leaders or consultants from the data available, usually draft or final reports. In turn, these forms were reviewed by ANL and ORNL technical support representatives for consistency and completeness. Thus, while an ef fort was made to obtain complete data, the nature of the work and individual local approaches has necessarily produced inconsistent and incomplete data.
]

Based on these data, the, federal investment of approximately $1.5 million thus far could ultimately return as much as $500 million to almost $1 billion in capital investment in the cities. Projects that are under construction or that are likely to begin construction soon total about $100 million; an additional $410 million or more may be invested in the other early-start projects. In the unlikely event that all the projects identified by the remaining cities (for which we have data) are built, the total investment could be substantially more than $1 billion in capital plant, transmission and distribution lines, and related capital costs. These figures generally do not include the costs of structure retrofitting, which could increase the totals by about 20%.

By building district heating systems that make it possible to use lower-cost fuels more efficiently than in conventional decentralized equipment, the community enhances its asset base and replaces money now spent on fuel with long-term capital infrastructure.

ECONOMIC AND JOB BENEFITS

As large enterprises, district heating systems produce many jobs. Jo estimates can be classified under four headings: direct construction, other industry, service, and operations and maintenance. Table 11 shows the estimated jobs in construction and industry. These figures are calculated estimates based on the specific systems identified by the cities. Job figures are estimated by using the construction of sewage collection systems and treatment plants as a proxy (since no direct figures for district heating construction projects are available). In turn, a model developed by the Bureau of Labor Statistics is used to estimate the number of job years per number of dollars spent on construction.

An entirely new district heating system would require construction of a central heat-only or cogeneration plant, transmission and distribution lines, and, depending on the system, in-building hookups. The scale may be reduced if some existing equipment or pipes are used. Construction is laborintensive, requiring such skills as heavy equipment operators, welders, pipefitters, and laborers, many of whom are now unemployed or underemployed. In addition to these direct on-site construction jobs, many industrial jobs may stand to benefit, ranging from mining to manufacturing pipe to driving trucks, and so on. Table 11 shows that at least 6700 direct construction jobyears would be created if all the projects proceed. These, in turn, would generate more than 17,500 other industrial job-years. (A job-year is the equivalent of one worker working full-time for a year; most projects would be constructed over a period of two to three years.)

Table 11 Jobs Created by District Heating Project Construction

city	Project Name	All Job Years	Construction Job Years
Albany	Institutional Loop	1,291	500
Allentown	Downtown Project	ND	-
Atlanta	4 Early-Start projects	654	260
Atlantic City	Marina Cove	124	48
Baltimore	Cherry Hill	ND	-
	Hopkins/E. Baltimore	991	219
Bellows Falls	Geothermal	49	19
Berlin	Geothermal	63	24
Cambridge	------	ND	-
Campbellsville	------	ND	-
Columbus	Ohio State U./CBD	5,649	2,205
Dayton	St. Elizabeth/Delco	1,479	580
Devils Lake	Steam Plant Conversion	58	22
Ecorse	Frenchman's Cove	ND	-
Fort Wayne	Ultimate System	269	106
Galax	Hanes Underwear	37	14
Gary	CBD/Incinerator	1,330	532
Holland	Power Plant Retrofit	338	132
La Grande	Institutional Corridor	159	62
Lawrence	Refuse Incinerator	2,107	815
Lewiston	Refuse/Cogeneration	337	131
Missoula	------	ND	-
New York	Navy Yard	ND	-
Norwalk	Incinerator	457	177
Provo	CBD/Brigham Young U.	1,060	410
Richmond	W. Richmond and Areawide/CBD	697	272
Santa Ana Pueblo	-----	ND	-
Springfield	Downtown	440	172
Thermopolis	Geothermal	ND	-
Total		17,589	6,700

Note: These are calculated figures based on data available as of October 1982.
ND = no data.,

Another factor used in determining economic benefits is the multiplier effect of employment. Multiplier jobs are those in the service sector of the economy and include restaurant employees, bank tellers, auto mechanics, retail clerks, etc. Although many of these require fewer skills and are lower-paying than construction jobs, they typically are generated in the community where the construction occurs and where unemployment may be highest. Standard ratios usually are used to estimate the number of jobs created in the service sector. These ratios vary among cities depending on size and location with respect to metropolitan areas. On a national basis, the standard ratio is 3:14 Using this ratio, the estimated number of service jobs created is 20,100 (6700 x 3).

The final category covers the permanent jobs required to operate and maintain the systems. No actual estimates are given here since the numbers vary widely depending on the kind of system, type of fuel, whether the system is new or an extension of an existing system, etc. Overall, however, the numbers are relatively small; even a large system may require no more than 10 to 20 people to operate, but it should be noted that system expansion is likely to continue, with its resulting impact on construction labor.

In addition to the jobs generated as a direct result of the construction and operation of a district heating system, other economic benefits can accrue to communities and the nation as a whole. By means of a proprietary model,* estimates have been made of the amount of economic activity that would result. Individual city estimates vary by factors such as type and size of city, and fuel used (fuels such as gas or oil purchased outside the city cause dollars to be 'exported," while dollars spent on indigenous fuels such as refuse are retained by the local economy).

The figures in Table 12 show that approximately $165 million will be retained in the cities' local economies in the first year of operation as a result of building district heating systems. The additional economic activity generated, considering the multiplier effects of dollars spent in the local economy, could be almost $500 million. The magnitude of these figures shows the level of economic activity that construction and operation of district heating systems would generate.

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*Developed by Resource Development Associates, Inc.

Table 12 Community Benefits of District Heating

City	Dollars Project Name	Net Indirect Benefits ($1000)	Economic Retained ($1000)
Albany	Institutional Loop	28,707	9,569
Allentown	Downtown Project	ND a	-
Atlanta	4 Early-Start Projects	14,647	4,881
Atlantic City	Marina Cove	3,965	1,322
Baltimore	Cherry Hill	ND	-
	Hopkins/E. Baltimore	18,953	7,846
Bellows Falls	Geothermal	299	199
Berlin	Geothermal	122	82
Cambridge	----	ND	-
Campbellsville	----	ND	-
Columbus	Ohio State U./CBD	144,715	48,238
Dayton	St. Elizabeth/Delco	98,217	32,739
Devils Lake	Steam Plant Conversion	468	312
Ecorse	Frenchman's Cove	ND	-
Fort Wayne	Ultimate System	4,445	1,482
Galax	Hanes Underwear	513	342
Gary	CBD/Incinerator	ND	-
Holland	Power Plant Retrofit	9,026	3,610
La Grande	Institutional Corridor	821	547
Lawrence	Refuse Incinerator	87,668	29,223
Lewiston	Refuse/Cogeneration	4,710	1,884
Missoula	----	ND	-
New York	Navy Yard	ND	-
Norwalk	Incinerator	19,528	6,509
Provo	CBD/Brigham Young U.	20,323	6,774
Richmond	W. Richmond and	ND	-
	Area-Wide/CBD	2,582	1,692
Santa Ana Pueblo		ND	-
Springfield	Downtown	25,375	8,458
Thermopolis	Geothermal	ND	-
Total		485,084	165,709

a ND = no data.

COMMUNITY AND ECONOMIC DEVELOPMENT BENEFITS

An economically feasible district heating project has a positive effect on the local economy because it creates jobs, reduces fuel bills, retains dollars in the community, and thereby frees energy dollars that can be spent for other goods, services, and investments. For residents, it can lower the cost of housing; for business and industry, it can improve competitive position, strengthen marginal businesses, and increase profits.

The opportunities to create and retain local jobs and to retain in the local economy dollars now exported to pay for fuel are the principal attractions of district heating. These are sufficient to warrant serious exploration of district heating systems. But many cities went beyond these overall benefits to look more closely at the ways district heating could help support the stated objectives for community and economic development.

One benefit could be in the systems' development-shaping potential; like sewer or water systems, district heating service areas may be used as tools for management of local development by providing assured thermal energy at a lower cost than that for decentralized systems.

Whereas economic benefits - jobs, dollars retained, etc. - can be estimated from capital cost, fuel type, and other project-related data, other community benefits cannot be readily quantified. Some generalizations can be made, but the individual community projects in themselves provide ample evidence of the value of district heating as a city revitalization tool, as indicated below.

Projects Ready for Construction

- Devils Lake: Conversion of the existing steam system to burn municipal refuse and agricultural waste will lower fuel costs to help stabilize the downtown commercial and residential area.
- Lawrence: The refuse plant now under construction will furnish thermal energy through a 1.3-mi-long steam line to one of the city's largest industries, the Merrimack Paper Co., and to various Lawrence Housing Authority properties enroute. A planned extension may serve the Arlington neighborhood, one of the city's poorest and most densely populated sections and a CDBG target area.
- New York: The Brooklyn Navy Yard project has been developing as a major industrial area of the city. The district heating system now in operation will help retain the 2200 jobs on the site and will be used as a selling point to attract more companies. A planned extension will serve a public housing complex and an adjacent lower-income residential neighborhood.

Projects Ready for Preliminary Design

- Atlanta: One of the four early-start projects would serve a 616-unit public housing project; the other three, various downtown commercial and governmental buildings. Eventually the projects would be consolidated and expanded to serve areas near the CBD that are in need of revitalization.
- Baltimore: Both projects are in CDBG target areas with the opportunity to serve several public housing complexes, the state penitentiary and city jail, a hospital, and several schools. The timing is fortunate because a number of public housing complexes have older internal heating systems in need of major repair or replacement.Portable boilers may be used temporarily until the district heating system can be connected.
- Norwalk: The system would be anchored by a major hospital, YMCA, and one of the city's largest plants, King Industries. Future expansion is planned to serve a mixed-use development.

Other Projects with Near-Term Potential

- Albany: Following construction of the Clinton Avenue project, which is expected to begin soon, the system may be expanded to serve 139 one-, two-, and three-family townhouses in the Arbor Hill Community Development Area. Two other projects have been identified. One would serve an institutional loop including hospitals, schools, and public and private institutions. The other would include the old Union Station, which is now undergoing adaptive reuse as a shopping center.

- Dayton: The areas proposed to be served by the St. Elizabeth and Delco projects generally correspond to the community development target areas. Major anchors include a large public housing project, several industrial plants and a hospital.

- Galax: The planned refuse-fired system would 'serve the city's largest employer, Hanes Underwear, and help retain its 1200 jobs.

- Holland: The district heating study area approximates the CDBG target area and includes the CBD (in need of substantial reinvestment), an industrial plant, -and Hope College, one of the city's largest e mployers.

- La Grande: The geothermal project will lower energy costs to the 'institutional corridor" consisting of several county buildings, a hospital, high school, and college.

- Lewiston: The city's high fuel costs and severe winters have affected the health of local industry. The system is planned to serve a number of industries, part of the CBD, and more than 50 apartment buildings, some of which have no central heating.

- New York: In addition to the Navy Yard project, three other projects under consideration would serve a fourhospital medical center, several lower-income residential areas, some public buildings, and industrial plants.

- Provo: The proposed retrofit of the municipal power plant for cogeneration would serve the CBD (facing competition from shopping centers), a hospital, a high school, and Brigham Young University (which would also supply heat to the system).

- Richmond: The West Richmond project would use the excess capacity of an existing state hospital boiler to supply steam to rose-growing greenhouses, a major Richmond industry with high energy costs and now facing severe competition.

- Springfield: The project, to be phased in over a 10-year period, would eventually serve a large part of the CBD and a large number of single and multifamily residences now slated for rehabilitation in the downtown and South End areas.

SUMMARY AND CONCLUSIONS

This catalog of projects and their service areas indicates the important role that the cities expect district heating to play in their overall development strategies. The cities see district heating as a way of helping to recoup some of their lost competitive edge by offering lower-cost thermal energy to business and industry. In a few instances, these costs may mean the difference between retaining and losing a major industrial firm.

Public buildings are particular beneficiaries of district heating. Lower energy bills here have a direct effect on government budgets. And at least 10 of the probably early-start projects are likely to serve public housing projects, initially using them to anchor the system. Many of these, as in Baltimore, have heating bills that are now a significant part of their operating budgets, coupled with heating plants in need of major repair. District heating can have a substantial and direct effect on lowering public housing operating costs. It can also lower costs for heating other buildings and even help to hold down health care costs by serving hospitals.

Finally, many cities with high landfill tipping fees or limited remaining landfill capacity have focused on refuse-fired district heating systems that, with proper environmental controls, convert the refuse problem into an energy source and a financial benefit.

Recognizing that the information available is preliminary - only a few of the projects had gone beyond preliminary assessment by early 1983 - it it clear that cities view district heating as an important way to improve their economics, cut costs, and strengthen their revitalization efforts.

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